MANUAL

OF THE

PHYSIOLOGY OF MAN;

OR,

A CONCISE DESCRIPTION

OF THE

PHENOMENA OF HIS ORGANIZATION.

BY PH. HUTIN.

Quidquid præcipies, esto brevis, ut cito, dicta
Percipiant animi dociles, teneantque fideles.
Hor. de Art. Poet.

TRANSLATED FROM THE FRENCH, WITH NOTES,

BY JOSEPH TOGNO,

STUDENT OF MEDICINE.

PHILADELPHIA:
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TO

SAMUEL JACKSON, M. D.

ASSISTANT LECTURER ON THE THEORY AND PRACTICE OF MEDICINE, IN THE UNIVERSITY OF PENNSYLVANIA, &c. &c.

THIS ENGLISH VERSION

OF

HUTIN'S MANUAL OF HUMAN PHYSIOLOGY

Is respectfully Inscribed,

As a feeble homage to his acquirements in this department of medicine in particular, as well as of general eminence in his profession; as a mark of respect for his acknowledged worth and talents, and as a testimony of gratitude, by his

Obliged Friend,

THE TRANSLATOR.

PREFACE

OF

THE TRANSLATOR.

My first attempt of this kind was, to render into the English language the last labours of the immortal Bichat: I mean his "*Pathological Anatomy.*" The favourable reception that work has received from enlightened physicians, has encouraged me again, to present myself before the medical public as a translator. I am farther led to this undertaking by a conviction, that neither the student of medicine, nor the young practitioner can better improve his leisure moments than by translating some useful work: These considerations have been the principal inducements to the accomplishment of the present translation.

This manner of becoming useful to our profession is certainly preferable to a rash and thoughtless attempt, at expressing our own *crude* ideas and undigested observations, by which we not only risk our reputation, but which might remain a monument of unprofitable absurdities, in spite of the most careful and polished diction.

Time only, and experience, enlightened and regu-

lated by a just observation; aided by a scrutinizing eye, which searches into the most hidden recesses of the mysteries of nature; and a mind endowed with a perspicuous and clear perception to record them, can alone presume, in our days, and especially in our profession, to produce an original work worthy of posterity.

But things are otherwise with respect to the translator: It is only necessary for him to possess a mastery of the two languages from and into which he translates, and at the same time to have a perfect knowledge of the subject on which he is employed.

These are the necessary qualifications; and when possessed, he may launch his bark into this "*sea of troubles*," though with little expectation of acquiring fame, for his tedious and irksome labours. But if, in the present attempt, I may only be *useful* to the students of medicine, by facilitating their arduous studies, I shall sincerely congratulate myself on the undertaking, while I indulge the hope, that it will be found by them, not entirely undeserving their approbation and careful perusal.

I have not aimed at elegance of diction, the nature of the work forbids it; and indeed, it could only be attained by a manifest sacrifice of the real meaning of the original text; but if I have not embellished my style with the flowers of rhetoric, I may unhesitatingly affirm, that I have never wilfully departed or deviated from the *true* meaning of my author.

I may be permitted to make a single observation on the arrangement of the matter of the work itself.

M. Hutin has followed the best classification, and the clearest and simplest method of instructing in the science of Physiology. He first gives us a graphic anatomical sketch of the apparatus or organ, &c.; and causes it to be immediately followed by the physiological function or mechanism of the apparatus or organ, &c. accompanied with a brief and condensed historical view, of the various opinions, facts or hypotheses, entertained or advanced, to explain the physiological functions of our organs.

In this manner, we not only possess the opinion of one author, or school, but the opinions of all countries, and men of eminence who have written on this subject; and the present work is believed, in this respect, to be the most correct summary of this science at the present time. And, in this opinion, I am confirmed by that of my friend Dr. Samuel Jackson.

April, 1828.

PREFACE

OF THE AUTHOR.

In the circle of sciences, there is not one which does not inspire the greatest and most lively interest; but that which has man for its object—his organization—his phenomena, possesses for us something far more seducing: in effect, does there exist for a reflecting being a more powerful charm than that of being able to penetrate into himself, and there to discover the mechanism of his functions, the wonders and mystery of his life? Therefore, Physiology is, in this respect, a science which should be studied by all;—in its study, man is struck by a multitude of delightful revelations; the philosopher finds in it the foundation of a sound doctrine; every one knows how much Bossuet urged the necessity of uniting physiology to the moral sciences: finally the physician must here imbibe the first principles of his science; without it, he is exposed at every step to the danger of falling into the most disgusting and dangerous empyricism.

We have on this important subject numerous particular memoirs, and treatises *ex-professo;* and in mentioning only those which do honour to our age, we shall particularly name the excellent

works of Messrs. Richerand, Dumas, Chaussier, Magendie, Adelon, &c. In presenting to the medical student a clear, simple, and rapid abridgment of the doctrines of these great masters, far be from me the idle pretension of producing a perfect work: I only aspire to the merit of removing the difficulties which embarrass their first steps, and of facilitating and accelerating their studies, in order to pay to this body the tribute of usefulness which it imposes on each of its members. The plan which I have followed in this manual, is nearly the same as that which is adopted in the school of Paris. I give at first some general considerations which serve as a natural introduction to the study of man; then I examine in particular, and in the aggregate, the different parts which constitute the human organization; finally, I conclude by the history of the functions, or different phenomena that man presents during the course of his life.

In the particular study of each function, I recall very cursorily the general condition and structure of the organ which is its instrument; then I explain the function itself; finally, after having described its mechanism and ultimate object, I pass in review the principal theories, or hypotheses, which divide physiologists: when I differ in opinion with them, I do it less from confidence in my own judgment, than in the observation of the learned men who appear to me to approach nearest to truth, and to a knowledge of the secrets of human nature.

MANUAL

OF THE

PHYSIOLOGY OF MAN.

General physiology is a natural science which treats of the phenomena belonging to organized bodies; but those bodies are innumerable, and besides they form two different kingdoms; physiology is then at first divided into *vegetable* and *animal*, according as vegetables or animals are the subjects of our investigation; finally, if we study life in one single species of these two living kingdoms, then physiology receives the appellation of *special*. Such is in particular that of man, of which we are about to treat.

INTRODUCTION.

General considerations of natural bodies.

The bodies or beings, the existence of which has been doubted by some metaphysicians, manifest their presence by a certain number of properties which produce in us an aggregation of definite sensations. The immense science which embraces them constitutes what is called natural philosophy.

In considering generally, and in a philosophical manner, the admirable variety of beings which compose the universe, we are struck with amazement

on seeing that all can be reduced to a certain number of elements which, according to the present state of science, amount to fifty-six, four of which are imponderable; but these elements or material parts of bodies, mixed in different numbers, or in diverse proportions, are bound together, in their combinations, by two distinct forces; the one, the power of chemical attraction, the other, that of organic attraction, which gives to them two peculiar modes of existence, which will for a moment fix our attention.

All the bodies in nature are either inorganic or organic. Every thing is different in these two classes of beings, not only in their material composition and power of aggregation, but also in the part they perform in the universe. The first glance suffices to establish between them, *à priori*, a distinctive character,—it is life, properly so called; and is only found among the beings whose particular structure assumes the name of organization, whilst inorganic bodies enjoy only a passive existence depending upon chemical affinities and physical laws. Let us briefly examine what are the material differences which exist between these two modes of being.

1. *Composition.* The inorganic bodies are composed of homogeneous molecules, united by a universal power, attraction, the ordinary conditions of which are well understood, in such a manner that the chemist may at pleasure decompose and reproduce them. Some of these molecules are elementary or indecomposable, and have generally a determined geometrical form; others are the result of diverse combinations that these latter form between themselves, and are called integrant. United in different quantities, and in an order more or less irregular,

these molecules constitute inorganic bodies, the volume and shape of which are very variable.

Organized bodies, on the contrary, are composed of heterogeneous parts; some solid, constituting the organs, others fluid, which are contained in these latter. These different dissimilar parts are united by a particular power,—*vital affinity*, the laws of which are entirely unknown to us; so that we are unable to decompose and recompose a vegetable or an animal. We distinguish in these beings chemical and organic elements, the union of which produces bodies of a determined shape and volume.

2. *Origin.* Inorganic bodies are sometimes completely formed by the combination of different elements, at others, they are detached from a mass, or are deposited by water which holds them in solution.

On the contrary, organized bodies are always produced by bodies similar to themselves; their reproduction occurs by a positive generation, nevertheless some moderns still admit, with the ancients, a spontaneous generation in the two organic kingdoms. (*Lamarck.*)

3. *Growth.* Inorganic bodies may at every moment considerably augment or diminish in volume; these phenomena, independent of themselves, always appertain to the general laws of matter.

Organic bodies, on the contrary, continually assimilate the nutritive particles of the bodies which surround them, and reject at the same time materials which previously formed them; this growth, by *Intus-susception*, constitutes nutrition properly so called.

4. *End.* Mineral substances can not necessarily have an end; exterior bodies are those which pro-

duce their destruction by greater affinities than those which have given them birth; the dissolution of their elements is never spontaneous.

Organized beings, on the contrary, have a determined end. Death, a name given to this end, happens with the entire cessation of the nutritive functions; the body then returns into the class of inorganic substances.

Mineralogy, chemistry, and natural philosophy, have for their object the investigation of inorganic bodies, whilst the knowledge of organization, and of the phenomena of organized bodies, belong to anatomy and general physiology; the numerous bodies which are the object of these two last sciences are divided into vegetable or inanimate beings, and animals or animated beings; the general characters that we have just pointed out in organized bodies, equally belong to both; but there exist between them some nicer distinctions, which justify us in the division of these beings into two distinct classes.

Difference between vegetables and animals.

1. *Composition.* We find in both classes an organization, but generally it is more simple in the vegetable than in the animal kingdom; with the former, solid particles predominate, whilst fluids prevail in the latter. In the former, one single organic element seems to exist, the *cellular*, whilst in the latter, three at least are distinguishable: the *cellular*, the *muscular*, and *nervous** tissues. Finally,

* Nevertheless, Haller, Linnæus and M. Brachet, consider the central marrow or pith of vegetables as corresponding to the nervous system of animals; and in recent researches, M. Dutrochet not only asserts that he has found in several plants nervous ganglia, but even muscular fibres.

the chemical composition in general, is also different; oxygen, hydrogen and carbon, are the chemical elements of vegetables. In animals we remark, besides the above elements, a great quantity of azote.

2. *Nutrition.* Beings of both organized kingdoms draw materials from the bodies surrounding them which they elaborate and assimilate to themselves; but vegetables feed on inorganic substances; animals, on the contrary, feed almost exclusively on organic matter. The former absorb and elaborate their aliments throughout their exterior, whilst in the latter, the alimentary substances undergo in a particular organ, the *digestive canal*, a special change, *digestion*, which prepares it for assimilation. Indeed we may say that this digestion in vegetables occurs in the earth, which, according to Hippocrates, is the stomach of plants, *quemadmodum terra arboribus ita animalibus ventriculus.*

Finally, nature has given to animals only, the liberty of executing at pleasure their nutrition, whilst vegetables nourish themselves in a passive and insensible manner.

3. *Sensibility.* Some vegetables have the power of receiving impressions and of reacting; but none possess sensibility, properly so called, i. e. that faculty in virtue of which a being has consciousness of himself, of his existence, of pleasure and of pain. Consequently their life is necessarily spent without perception or volition.

Animals, on the contrary, which possess this faculty, are conscious of their existence, perceive and execute at will certain actions of their life, and experience sensations of pleasure and of pain.

4. *Locomotion.* This faculty, by which the body has the power in part, or altogether, of changing

place at will, exclusively belongs to animals; whilst vegetables are fixed to the soil, germinate, grow, and die in the same spot: it is erroneously supposed by some, that certain bulbous plants have this faculty in common with animals. When they are observed for several years, it is evident that they have changed place; but let us reflect that it is no longer the same plant, it is a new bulb which grows alongside of the parent, which dies every year with the plant that it produces.

From these two faculties, proper to animals, arises a third, which is equally peculiar to them—*language.*

5. *Generation.* In animals, reproduction occurs by the voluntary union of two individuals of different sexes, whilst the greater number of vegetables are hermaphrodites, *i. e.* the same flower bears the two sexes; fecundation is mechanical, and is involuntarily performed. But there exists another mode of reproduction, which has the greatest analogy in the two species of organized beings; it is simple, and happens without the concurrence of two sexes. The Confervæ, the Polypi for example, cover themselves with gems or buds, in the same manner as many plants do, and which, in dropping off, give birth to new beings similar to the parents which have produced them.

In the comparative examination that we have just made between animals and vegetables, we must have remarked that these beings differ only in the degree of complication or of simplicity, and if we reflect that in order to establish differences, we have been obliged to compare the most elevated among them, it will be easy to foresee, that in descending the animal scale, nature will present a

multitude of exceptions, which will always oppose a division to which she seems unwillingly to consent. In effect, there are animals in whom we have not been able to find the organs of sensibility and of motion, whilst, on the other hand, new researches seem to have fixed beyond doubt the existence of these instruments, and consequently of functions, in some plants.

Of Animals in general.

From the knowledge, which we have just acquired, we may define animals to be living organized beings, sensible, receiving consequently various sensations from the different bodies which surround them, and the greater number enjoying a free and independent existence.

Generally, animals have a symmetrical form, and may be divided into two lateral halves by a vertical line; they are provided with a nervous system expanded on the one part, throughout the whole body, and ending on the other by an enlargement; they have organs for special sensations to establish relations with the universe; they are covered with an exterior membrane, *the skin*, which being reflected internally, forms a cavity destined to receive the aliments. From this cavity commonly arise numerous vessels which absorb the alimentary juice and distribute it in all parts of the body; finally, most animals have respiratory organs in which this matter is exposed to the action of the air, secretory organs, where a part of this nutritive juice is eliminated from the mass; muscles to perform motions; finally, genital organs for the reproduction of the species.

Such are the general characters of animal organization; but it undergoes such great modifications, from the simplest animals to those which occupy the highest grade in the scale, at the head of which stands man, that I believe it important to prepare ourselves for the study of the latter, by taking a general view of organization and the functions of the different classes of animated beings, so as to enable us to investigate nature from its simple to its compound form.

1. *Nutrition.* In the lowest animals, the *amorphous*, the mass is homogeneous, spongy; there is no particular organ, the absorption of nutritive materials is effected throughout the whole surface of the body. Next, in the *radiated animals*, we distinguish the rudiments of a digestive canal; we find a simple cavity, or with radiated prolongations in every part of the animal: here the nutritive absorption occurs through two surfaces. Finally, as we ascend the scale, this cavity traverses the body, the aliment is therein received through an orifice called *the mouth*, and the residue is rejected by another opening, *the anus.*

At first, the nutritive juice is immediately carried by imbibition throughout the body, without the intervention of vessels; such is the case in the *radiated* animals and *insects.* In more elevated classes, the fluid absorbed in the intestinal canal circulates in vessels divided into arteries and veins, at the union of which is often found a heart simple or double. In the *vertibrated* animals, there exists besides limphatic and chylopoetic vessels.

With the greater number of animals the nutritive fluid requires the contact of the air, in order to be proper for nutrition; and for this end there is a respiration. The *radiated animals*, and a few of the

articulated, have no particular organ for this function, then respiration is called *general;* with all the other animals, on the contrary, this function is located; and according as it is executed in water or in the air, the organs are modified and assume the name of *gills* or *lungs*.

The nutritive fluid is assimilated to the organs in the same way in all the classes of the animal kingdom; it renews their substance and keeps up their temperature.

The movement of decomposition is also variable in the diverse animals, as well as that of composition. The nutritive fluid has continually secreted from its mass some of its parts, that which constitutes the *secretions*, the results of which differ accordingly as they are immediately rejected on the exterior, or as they return into the nutritive element. In the *infusoria*, *polypi*, *acalephœ*, *echinodermata* and *intestinal worms*, this function is confined to a simple exhalation, of which the surface of the body is the seat. In certain *arachnida*, *crustacea*, and *mollusca*, we find a liver and salivary glands; the vertebrated animals have besides two kidneys, a pancreas, &c.

2. *Sensibility*. All animals seem to enjoy this faculty; but they do not possess it in the same degree; the nervous system is the instrument of this function. In the *infusoria*, and the greater number of polypi, this system seems to be wanting. We begin to perceive the rudiments of it in the greater number of the radiated animals; we observe round their mouth small ganglia, communicating with each other by small filaments, which extend beyond and are distributed to both surfaces of the body; no central ganglion does yet appear to

exist: impressions are immediately followed by motion.

The central enlargement called *brain,* is observed in the *articulated animals.* It is situated over the œsophagus; it sends all along the digestive canal two filaments, which are united opposite to each articulation, and are distributed to every part of the body. The *mollusca* present nearly the same arrangement; in the *cephalopoda* only, the central ganglion is enclosed in a kind of cartilaginous cranium.

The nervous system in these two classes is already modified in such a manner as to give birth to organs of special sensations; some have tentacula or feelers appropriated to the sense of touch, the greater number perceive odours, nevertheless, with them this faculty, as well as that of perceiving sounds, seems to depend upon a tactile impression, since no organs of these senses are as yet discovered. The *gasteropoda* present small black spots that are considered as the rudiments of the organ of vision: the *insects, arachnida, crustacea,* the *mollusca cephalopoda,* &c., have simple or compound eyes, often *pediculated.* We see that the complexity of the nervous system in these two classes of animals continually increases; these latter evidently possess the nervous centralization in a higher degree than the preceding, hence the freedom of their movements; they have organs of the senses, hence again special sensations; finally, from these two faculties results a third which, without education, tends to the preservation of the individual and the species,—it is *instinct.*

Lastly, in vertebrated animals, the same filaments are no longer indistinctly sent to the organs of vegetative and animal functions. The nervous

system assumes a peculiar character; it is always composed of two principal parts: 1. Of the union of numerous ganglia analogous to those we have already observed in the inferior classes, and which have under their dependance the organs of nutrition and the principal organs of reproduction; this is called the *great sympathetic*. 2. There exists, moreover, another nervous mass, with which communicate the preceding enlargements, and which consists, 1. In a long cord contained in the vertebral canal, called *spinal marrow*, whence arise all the nerves which impart voluntary locomotion to muscles. 2. In an enlargement more or less considerable, ordinarily contained in a bony case called cranium, this is the *encephalon*, to which all the organs of the senses tend, and which presides over the moral faculties. This organ, as we gradually rise towards man, more and more connects and binds under its dependence the whole nervous apparatus, and indeed we may even say life.

Thus in the class of vertebrated animals, besides irritability, general sensibility, voluntary movement and instinct, we also observe *cerebral acts*, which gradually arise up, even to intelligence.

3. *Locomotion*. This faculty, possessed by animated beings, for executing partial or general movements, is gradually extended in the series of animals. Among those which occupy the inferior classes, we do not find particular organs for this function, and nevertheless the *infusoria*, for example, move about with an astonishing velocity; the same thing is the case with respect to the *rotiferi* and the *polypi*, which are likewise deprived of muscular organs: they begin to be appreciable in the *acalephæ* and *radiated* animals. Afterwards, the

apparatus of this function is more complicated, and in the same degree as the muscular system is more developed, there are added hard parts, which form the frame of the body and the levers of the limbs. In the *insects*, the hard parts are external, forming a part of its covering; they are composed of parts moveable on each other: the muscular fibres line their interior and communicate to them motions. In the immense class of vertebrated animals, on the contrary, these hard parts are internal, and constitute peculiar organs, the *bones*, about which the muscles are attached.

4. *Expressions.* This faculty, possessed by ani mated beings of communicating their sensations, differs very much in different animals; it is not remarked in those which are deprived of sentiments and volition. Next it develops itself, but it is only appreciable to the eye; the passions which agitate the animal are then only discovered by the different changes which occur on his surface, constituting *gestures.* Lastly, the superior classes have besides a peculiar instrument—the *larynx;* placed along the respiratory passage; it produces a kind of expression which consists in sounds; voice and speech, are modifications peculiar to man.

5. *Generation.* In the inferior classes there are no particular organs for reproduction; then, sometimes, as in the *infusoria*, the body may be divided into several fragments, which constitute as many new individuals (*fissiparous generation;*) or by buds shooting on the surface of the animal, detaching themselves from the parent to produce a new being, such are *polypi*, (*gemmiparous external generation;*) or lastly, as it is observed in *acalephæ*, it is internally that the gemmæ oviform are develop-

TABLE OF THE ANIMAL KINGDOM.

1. AMORPHOZOAIRES, Homogeneous organization, no appearance of digestive, nervous or muscular organs.

2. ACTINOZOAIRES, or *radiated animals.* Radiated form, digestive cavity with one or two openings; nervous system nul, or it consists in ganglia placed opposite each radia of the animal; these ganglia have not as yet a common centre, they are indifferently distributed to both surfaces. No rudiment of muscular apparatus does yet exist; generation fissiparous or gemmiparous.

3. ARTIOZOAIRES, *symmetrical form,* it comprehends the

- MALACOZOAIRES, or *mollusca.* Soft body, made out of a piece, no articulation; perfect digestive canal, chylopoetic vessels; pulmonary or bronchial respiration; double fleshy ventricle which receives the blood from the respiratory organs and sends it into every part of the body; secretory organs, liver, and salivary glands; generation with the concurrence of the sexes. Some species are hermaphrodite; they have a brain and a spinal marrow situated along the digestive canal: some have eyes; there are even some which appear to enjoy the five senses.
- ENTOMOZOAIRES, or *articulated,* subdivided into:
  - ANASTEOZOAIRES external articulation or *invertebrated.* Body borne commonly on paws; intestinal canal complete; tracheal respiration disseminated; no circulation properly so called; besides the muscles, the locomotive apparatus presents some hard parts, but they are external and dependent upon the skin; spinal marrow under the digestive canal: in some respects these animals are inferior to the mollusca.
  - OSTEOZOAIRES, internal articulation or *vertebrated.* Different from the preceding by the animal functions; their body is composed of a trunk divided into two or three splanchnic cavities: almost all have limbs; a series of hollow bones forming a long shaft occupying the middle line of the body, and which contains the spinal marrow; at its extremity is the head, composed of the cranium, in which is contained the encephalon, and of the face which presents the mouth and the organs of the senses: the mouth is composed of two horizontal maxillary bones, furnished with teeth or horny matter: the intestinal canal is provided with secretory glands, which are commonly the salivary glands, the liver and pancreas; all have a double circulation, a heart, arteries, veins, lymphatic, chylopoetic vessels, and lungs, fishes excepted which have gills: the sexes are separated; all the vertebrated have moveable bones which form their frame, muscles which are inserted into them by the medium of tendons, and which move them; lastly, they all have red blood; and among the excretions, the greater number have a urinary depuration.

According as the fœtus has acquired, or not, all its development when it is expelled, or is born, contained or not in its membranes; we subdivide the vertebrated animal into:

Oviparous. The germ is inclosed in its membranes with sufficient nutritive substances for its alimentation, till it is hatched. Birds, reptiles and fishes are comprised in this order. Certain reptiles and some fishes keep their eggs within, till the time of hatching: these are the ovo-viviparous.

Viviparous. The egg fixed in the uterus, receives its nutrition through the placenta, which establish its communication with the mother; it is expelled when it has attained all its development. Their animal functions are more perfect, their instinct greater; this family has a peculiar organ (the mammæ,) destined to prepare the first nourishment of the new born. It is to this species that man belongs, who surpasses all beings in intelligence.

ed, and this constitutes internal gemmiparous generation. In higher animals, the concurrence of two organs of different sexes is needful for reproduction. These organs are mostly borne by different individuals. The only hermaphrodites are the *amulati*, and even then they reciprocally impregnate each other.

Classification of Animals.

Linnæus, in considering the circulatory apparatus, established in the animal kingdom two great classes; the *red* and the *white blooded animals;* then he subdivided the first class into four orders: *Quadrupeds*, *Birds*, *Reptiles*, and *Fishes*. The second class comprehends the *Insects* and *Worms*.

M. Lamarck, judging from a striking character in the locomotive apparatus, gives to these two classes the names of *vertebrated* and *invertebrated*. At first M. Cuvier had received this classification; he subdivided the first class into four orders as Linnæus, but he recognised five in the second: The *Mollusca*, *Crustacea*, *Vermes*, *Insecta* and *Zoophyta*. Afterwards this great naturalist, taking into consideration the animal functions, divided the animals into four classes: the *radiated*, *mollusca*, *articulated* and *vertebrated*. Finally, M. De Blainville founded also on the character of organization, the classification of which we are about to speak.*

Now that we are going to establish a parallel between inorganized and organized bodies, between vegetables and animals, and that we have risen from the humblest of these beings up to man, we have naturally reached the degree of knowledge

* See the table on the opposite side.

needful to enter upon the particular study of the latter.

OF MAN.

Without making man our particular study, we have already pointed out several traits which belong to him; but from the rank which he occupies among animals, we must expect to find in him, independently of the general characters which he participates in with the latter, an admirable degree of perfection in his organization and faculties.

Anthropology, or the science of man, comprehends the study of his structure, and that of his phenomena.

Organization of Man.

The exterior formation of the human body is symmetrical; a vertical middle line, called the Raphe, indicates the point of union of the two lateral halves. This symmetry that we particularly remark in the organs of animal functions, is nevertheless not perfect; it is still less so in the organs of generation, lastly it disappears in those of the nutritive functions.

The structure of man constitutes an organization, consequently we meet in him, as in all organized beings, solids which compose the organs, and liquids which are circulated in them.

Of Solids or Organs.

We call organic solids every part of the body which gives to it its form, and imparts to it motion, and the molecules of which are sufficiently adhesive

between themselves not to separate the one from the other, and not to obey the laws of gravitation.

Anatomists have not agreed on the number of solids. M. Chaussier confines them to the twelve following:

The *bones*—are evidently the hardest solids; they form the frame of the body, and the levers of the limbs.

Cartilages—are, after the bones, the hardest part; they are destined to tip the articulating extremities of the bones, or to lengthen them.

Ligaments—are organs difficult to tear, calculated for strength; some belong to the bones, and others to the muscles.

Muscles—are red contractile organs destined for motion; they form the principal mass of the body.

Vessels—are canals in which the fluids circulate.

Nerves—are organs of a soft and pulpy nature, which are the agents of sensibility.

Ganglia—are globular organs situated along vessels or nerves, formed by the union of the one or the other, and destined to produce modifications in the fluids which circulate in these organs.

Follicles—are generally small organs destined to separate from the blood a humour proper to lucubrate the membranous surfaces which are liable to come in contact with external bodies.

Glands—are also organs of secretion, but of a more complicated organization, and always furnished with a distinct excretory canal.

Membranes—are tissues serving to form, support and line the different organs. Bichat divides them into simple and compound, according as they are formed by one or by two lamellæ.

The cellular tissue is a kind of net-work serv-

ing to bind as well as separate all the organs of which it forms the Parenchyma.

Finally, the *viscera* are the most complex solids of the human body, situated in the abdominal cavity, and destined for the support and propagation of life.

In this classification of the solids, which is pretty generally admitted, we might, I think, place at the head of the list, the *teeth*, of which M. Chaussier makes no mention.

The inorganic solids are held in a state of equilibrium by the expansive power of caloric, which tends always to separate the molecules, and the affinity which holds them together. Is this the case with the organic solids? The greater number of physiologists ascribe the solidity of these latter to an unknown power,—*life*. What is certain, is, that the solids are only decomposed after death, although their condition is more or less altered in sickness.

The ancients reduced the organization of solids to two elementary fibres, which they considered as being composed of earthy matter and gluten; they divided it into liniary and lamellated; and according to them, from this fibre arose the cellular tissue, which afterwards engendered all the organs, which they divided into symmetrical or double and single.

First, it is evident that this microscopic fibre is only the creation of the mind; besides, the cellular tissue is not the only elementary tissue of our organs, as we shall prove.

Modern anatomists acknowledge three elementary tissues, the cellular, the muscular, and the nervous.

The *cellular* tissue, is that which most generally abounds; it is the only one which we remark

in the inferior animals; in the others, it forms the web of every organ; it is condensed into skin over both surfaces; hollowed out into canals; gives birth to the vessels, &c.; it is essentially composed of concrete gelatine.

The *muscular* tissue. This is generally less diffused; it is composed of contractile globules which, according to M. de Blainville, are formed in the cellular tissue.

Finally, the *nervous* or *medullary* tissue is still less diffuse than the preceding; it is likewise composed of globules, and according to M. de Blainville, it is developed in the muscular fibre.

To these three elementary tissues, M. Chaussier adds a fourth, which he calls *albugineous* fibre; but it is generally considered no other than condensed cellular tissue.

These tissues being simple, woven together, or being modified in different manners, give birth to all the organs of the human body; and these organs, uniting into groups for the execution of a function, constitute the apparatuses (*appareils.*)

Bichat likewise rejects the elementary fibre of the ancients, and considers the composition of all the organs to consist of *twenty-one* tissues, seven of which he calls *generators:* the *exhalent*, *absorbent*, *cellular*, *arterial*, *venous*, the *nervous organic*, and *nervous animal*. The other *fourteen* are formed by these, but combined in different numbers and proportion, and covered with special substances. Bichat has called them for this reason *compound* tissues; they are the osseous, medullary cartilaginous fibrous, fibro-cartilaginous, muscular animal, muscular organic, mucous, serous, synovial, glandular, dermoid, epidermoid, and pilous systems.

Béclard has modified the doctrine of Bichat, and has classified the organic solids of the human body into the *eleven* following tissues: the *cellular, adipose, serous, tigumentary, vascular, glandular, ligamentous, cartilaginous, muscular*, and *nervous*.

All these tissues are not, as some anatomists have supposed, the production of the imagination: they essentially differ from each other with respect to their physical properties and organization; and in whatsoever part of the body they are found, their actions are every where the same, and distinct for each individually. The same thing is the case with respect to their diseases. Messrs. Pinel and Carmichael Smyth have remarked, for instance, that the inflammation of a simple tissue occurs in the same manner in all organs.

Of Fluids or Humours.

We give this name to all the parts of the body, the molecules of which have so little cohesion, that they can easily glide over each other, and are divided by their own specific gravity.

Caloric and water are the principal agents of fluidity; but there exists moreover a particular power depending on life, which prevents the decomposition of these humours, as is demonstrated by the alterations which they experience as soon as they no longer form a part of the animal.

According to the degree of separation of their molecules, the fluids exhibit themselves in a liquid or gaseous form; and from their composition they are said to be simple or compound: in the latter case they hold different bodies in solution.

The ancients reduced all the humours of the body to four, viz. the *blood, pituita, bile* and *atrabile.* To each of these four humours corresponded one of the four ages, one of the four temperaments, and one of the four seasons.

Afterwards the humours were classified according to their physical and chymical properties: into *acids, alkalines,* and *neutral, saline, oily, soapy, mucous, albuminous, fibrinous,* &c.

They have since been classified, according to their use, into *alimentary* and excrementitious; this classification has been adopted by Bichat. M. Richerand believes that all the humours are *recrementitious excrements.* M. Chaussier divides them into five classes: the chym, the chyle, the lymph, the blood, and the secreted humours.

We may very well, according to Messrs. Béclard and Adelon, confine the humours to three principal ones; namely:

1. *Humours of absorption.*—They are composed of all the nutritive fluids derived from the exterior, such as chyle and the oxygen of the air; 2. The other materials are derived from internal absorption, such as the lymph, and some other principles not well understood, derived from venous absorption; all these fluids unite to form the blood.

2. *Humours immediately nutritive,* or *arterial blood.* It results from the union of the preceding fluids, modified in a remarkable manner in the act of respiration by one of them,—*oxygen.*

3. *Secreted humours.* They are derived from the blood and are extremely numerous; we may subdivide them, according to the form and organization of the organ which produced them, 1st. into *perspiratory* humours; such are cutaneous and pul-

monary transpiration, the sero-synovial humours, the fatty, all the humours of the eye, the lymph of *Cotugno*, the liquor amnii, that of the umbilical *vesicle*, &c.; 2dly *follicular*, *cerumen*, the *meibomian* humour, and the different mucous fluids; 3dly, the *glandular*, formed in the glands furnished with an excretory duct; such as the *lacrimal*, *salivary*, *pancreatic* humours, the *bile*, *urine*, *sperm* and *milk*.

Such are, in general, the fluids of the human economy. We shall speak again of each in particular when we shall have arrived at the function to which they respectively belong.

The solid and fluid parts in man, as well as in other animals, are continually converted into each other; hence their composition is the same: the immediate principles are fibrine, gelatine, albumen, mucus, oil, water, sugar, osmazome, resin, urea, *picrocholine*, *zoohemotine*, phosphat and carbonate of lime; acetic, lactic and oxalic acids, &c.: these substances are themselves composed of a certain number of ultimate elements, which are oxygen, hydrogen, carbon, azote, phosphorus, sulphur, chlorate, iron, manganezium, calcium, potassium, sodium, silicium, magnesium, aluminum, and the imponderable fluids, such as caloric, electricity, &c.

The fluids in the human organization abound more than the solids, but the proportions are difficult to determine; they must vary according to individuals, ages, sexes, &c. M. Richerand asserts that the humours are to the solids as 6 is to 1. Chaussier supposes that they are as 9 to 1.

Of vital Force or Principle.

We must understand by this word the union of the power and the laws which animate and govern

the animal organization. Struck with the extreme differences which are presented by all the bodies in nature, the ancient philosophers admitted in the organized bodies a principle of special actions. This idea, revived under the name of vital principle, has experienced in our days several modifications that it will be proper to mention. Physiologists have made of this principle the subject of violent contention, and by dint of reasoning, some have even gone so far as to confer on this metaphorical being a real existence; some have confounded it with the rational soul; others have considered it as a faculty of matter; lastly, some consider it inherent in organization.

Human organization presents during life a numerous series of different phenomena, which may be referred to three different orders. Some are evidently of a chemical nature; others are the result of physical and mechanical laws; thirdly and lastly, we have the vital phenomena; these latter continually modify the former, their cause is the principle which is the object of our inquiry; it is this cause which exempts us from the operation of the universal laws which inorganized bodies obey; it is to this latter that we must refer the intellectual and moral phenomena.

This power comprehends several distinct faculties. 1st. It is called *vital affinity* or *power* of *formation;* it presides over the action of generation, nutrition and the cohesion of all the parts. 2dly, *Irritability;* it consists in immediate impressions followed by movements more or less appreciable: hence arise the varieties called tonicity, vascular contractility, and muscular action or *myotility* (*myotilité*). 3dly, lastly, *sensibility* or nervous power, which comprehends

all the impressions perceived, the special sensations, and latent sensibility, that many physiologists do not admit. There is still another faculty peculiar to man and of a more elevated order; it is the intellectual and moral actions.

Many modern physiologists ascribe all these vital properties to a single one,—*sensibility.*

Of Organism, or phenomena of Organization.

Now that we understand human organization, and the force which animates and governs it, we arrive at the study of its phenomena or *organism,* to use the happy expression of *Stahl.*

The actions of man are already partially known to us; we have successively presented them, in our general considerations of the living kingdom, and nearly in the order of their development. In effect, for the sole reason that man is an organized being, we know already that his actions constitute life; and also, as he is an animal, we know that he enjoys the faculty of feeling, moving, of expressing his passions, and of being the arbiter of his life; lastly, man being binary, vertibrated, and *bimanus,* the mechanism of his functions is the most complex, and he is endowed with peculiar faculties, such as speech, intelligence, &c. &c.

All the organic actions unite to form a certain number of functions, between which exists, according to their importance, a singular order of subordination; notwithstanding this dependence of functions, there exists between them so intimate a connexion, that they seem to be reciprocally entwined and to acknowledge no other influence than that of the intelligence.

Functions have some general characters and

TABLE

OF THE ORDER ESTABLISHED IN THE STUDY OF THE FUNCTIONS.

- **FIRST CLASS.** FUNCTIONS USEFUL TO THE LIFE OF THE INDIVIDUAL.
  - **FIRST ORDER.** By assimilating to his own substance the aliments on which he feeds. *Functions of Nutrition.*
    - 1st Genera—*Digestion:*—Extracts the nutritive part.
      - Apprehension of the aliments,
      - mastication and insalivation,
      - deglutition,
      - chymification,
      - chylification,
      - defecation,
      - accidental excretions.
    - 2d Genera—*Absorption:*—Carries it to the mass of the humours.
      - of chyle,
      - lymphatic and venous.
    - 3rd Genera—*Respiration:*—Combines it with the oxygen of the air.
      - inspiration,
      - expiration,
      - sanguification,
      - alteration of the air,
      - alteration of the blood.
    - 4th Genera—*Circulation:*—Distributes it in every organ.
      - action of the heart,
      - action of the arteries,
      - action of the capillary vessels,
      - action of the veins.
    - 5th Genera—*Assimilation:*—Assimilates it to their own substance to repair the waste.
      - composition,
      - decomposition.
    - 6th Genera—*Calorification:*—Entertains the heat of the body at the same temperature.
      - influence of the lungs and nervous centres.
      - of heat,
      - of cold.
    - 7th Genera—*Secretions:*—Constantly secreting a part of the mass of the blood.
      - Exhalations
        - serous,
        - cutaneous,
        - adypose.
      - follicular secretions
        - sebaceous,
        - mucous,
      - glandular secretions
        - tears,
        - saliva,
        - pancreatic juice,
        - bile,
        - urine.
    - 8th Genera—*Innervation:*—Imparts motion to all the preceding functions.
      - influence of innervation on the organic functions.
  - **SECOND ORDER.** By establishing his relations with the beings which surround him. *Functions of Relation.*
    - 1st Genera—*Sensations:*—They warn him of their existence.
      - touch,
      - taste,
      - smell,
      - sight,
      - hearing,
      - internal sensations,
      - morbid sensation.
    - 2d Genera—*Intellectual faculties:*—Know and judge them, and reason about them; and the *affective faculties*, seek or shun them.
      - of their organs,
      - of their source,
      - of circumstances which modify them,
      - of their appreciation, *à priori*.
    - 3rd Genera—*Motions:*—They approach or remove him from them.
      - natural station
      - soliped,
      - kneeling,
      - sitting,
      - standing on the head,
      - lying,
      - walking,
      - jumping,
      - running,
      - swimming,
      - mechanism of the superior limbs.
    - 4th Genera—*Expressive phenomena:*—Enable him to communicate with his species.
      - gestures,
      - voice,
      - speech.
    - 5th Genera—*Rest of the functions of relation.*
      - sleep.

SEXUAL DIFFERENCES.

- **SECOND CLASS.** FUNCTIONS WHICH SERVE TO PRESERVE THE SPECIES.
  - Some require the concurrence of both sexes.
    - Copulation . . . .
      - action of man,
      - action of woman
    - Fecundation . . . .
      - action of man,
      - action of woman,
      - doctrines of fecundation,
      - epigenesis,
      - evolution.
  - Others are exclusively bestowed on the female.
    - Development of the ovum in the uterus,
    - History of the membranes of the fœtus,
    - Physiology of the embryo and fœtus,
    - Of gestation,
    - Accouchement,
    - Lactation.
- **APPENDIX**
  - Ages.
    - 1st Infancy,
    - 2nd Infancy,
    - Adolescence,
    - Virility,
    - Old Age.
  - Individual differences
    - Idiosyncrasies,
    - Temperaments,
    - Constitutions,
    - Habits.
    - Human races.
      - Caucasian,
      - Ethiopian,
      - Mongolian.
  - Sympathies.
  - Synergies.
  - Death . . . .
    - Natural,
    - Accidental.
  - Cadaveric Phenomena,
  - Putrefaction.

peculiar traits which distinguish them from each other. First, they have each an apparatus of distinct organs in the human economy, then each of them performs a different part; but they all tend to the same end, that is, the preservation of man as an individual and as a species; they are, according to the expression of M. Richerand, *his means of existence,* it is from their harmonic unity that life results. Their study is the object of physiology.

Number of Functions.

Physiologists do not agree on the number of functions in man. Vicq-Dazir and Fourcroy admit nine of them: *digestion, circulation, respiration, nutrition, secretions, ossification, irritability, sensibility,* and *generation.* M. Cuvier likewise admits nine of them, but differing from the preceding: *sensations, movements, digestion, absorption, circulation, respiration, transpiration, excretion* and *generation.* Bichat admitted thirteen of them: *digestion, absorption, respiration, circulation, nutrition, secretions, external senses, internal senses, movements, voice* and *speech, generation, exhalation;* and *calorification.* M. Richerand reckons ten of them: *digestion, absorption, respiration, circulation, nutrition, secretions, sensations, movements,* the *voice,* and *speech,* and *generation.* M. Chaussier finally acknowledged twelve of them, which are: *respiration, circulation, innervation, digestion, absorption, nutrition, secretions,* the *external senses,* the *internal senses, locomotion, voice* and *generation.*

Classification of the Functions.

Physicians agree as little as to the order in which the functions ought to be classified, as with respect to their number; every Physiologist has created or modified a classification, so that there exist a great number. I believe it to be impossible to establish a perfect one, so close is the connexion of the functions, of which the actions are simultaneous and requisite, *in circulum abeuntes* (Hipp.); nevertheless, the order in which the functions of man are studied, is not altogether indifferent; that which is followed in the Medical School of Paris seems to me preferable to all others. The classification of Professor Richerand is simple and natural; he considers the functions nearly in the order of their development in the different classes of the animal kingdom; we shall only add some modifications in the subdivisions. *(See the table.)*

FIRST CLASS.

LIFE OF THE INDIVIDUAL.

FIRST ORDER.

FUNCTIONS OF NUTRITION.

CHAPTER I.

OF DIGESTION.

Digestion is that function by which the external nutritive substances, (*aliments* and *drinks)* are introduced into an apparatus of organs, to be there converted into a peculiar organic matter proper to repair the waste of the economy, and fitted to its growth.

Its history will comprehend, 1st. The study of the aliments and drinks; 2dly, some considerations on the apparatus of the function; 3dly. lastly its mechanism.

ARTICLE 1.

1. Of *Aliments.* These include all the natural substances, solid or liquid, which, submitted to the digestive organs, is renderd fit to repair the solid part of the blood. Many remedies are nearly in the same case; nevertheless, in general we ascribe to them the character of resisting the digestive action.

The most natural division of the aliments is

drawn from their vegetable or animal nature, although some physicians have considered these two kingdoms as being identical; nevertheless, it is very certain, that vegetables are not so easily triturated and converted into chyme as animals; that their nature is more distant from that of man; consequently it is necessary to eat a greater quantity of them; they require also a greater capacity in the digestive apparatus.

Man, notwithstanding the opinion of some philosophers, is essentially *omnivorous*, and most generally his taste leads him to mix the two kinds of diet; but the one being very stimulating, and the other on the contrary debilitating, he causes them to predominate by turns, according to the quarter of the globe that he inhabits; thus vegetable diet is that of the burning regions of the equator, whilst on the contrary, it is at the expense of animal life that man lives in the frozen climates of the polar regions.

The nutritive principles of animals are fibrine, gelatine, albumen, osmazome, caseum, butter, fat &c. those of vegetables are sugar, fecula, gum, mucilages, acids, oils, gellies, gluten, tanin principle, &c. The mineral kingdom furnishes only seasoning.

The ancients, according to *Hippocrates*, have admitted in all aliments one alimentary matter always the same: *Hallé* is the first who objected to this opinion; nevertheless the question remained still unsettled, when the chemists, and particularly M. *Marcet*, in showing that the chyle essentially differs, according to the nature of the aliments, has put an end to all debates.

2. Of *Drinks*. We designate under this denomination all liquids introduced into the digestive tube for the purpose of repairing the fluid parts of

the blood, they are taken to allay thirst, and dissolve the solid aliments; lastly to excite the gastric organs, and even the whole economy.

Water was for a long time the first and only drink of all animals; but man has since been able to procure a number of others, that he employs, it is true, rather for the purpose of indulging his taste and satisfy his sensuality, than that of allaying his thirst. They may be all referred to the three following classes.

1. Water, and drinks of which it is the base, which neither contain aromatic nor alcoholic principles; 2. The watery drinks, impregnated with aromatic principles; 3. and lastly, those, the active principle of which is alcohol.

ARTICLE 2.

Of the Digestive Apparatus.

In man it begins at the head, crosses the neck, the thorax, fills up nearly all the abdomen, and terminates in the anus. It presents the following parts for our consideration:

1. The *Mouth.* It is a parabolic cavity in which, or about which, we meet with the organs of taste, mastication and insalivation. It presents anteriorly the *lips*, a very moveable veil, separated by a transversal fissure, which forms the entrance of the digestive canal; behind it, is the *isthma fauci*, an opening which leads to the pharynx, concealed in the natural state of the parts by the *velum pendulum palati*, which rises at the time of deglutition to stop up the nasal passages; above, is a solid partition named the *palatine vault;* below, we observe the *tongue*, the organ of taste, the *cheeks* and the salivary organs;

finally, the mouth presents the apparatus of mastication, which is composed of two *jaws*, distinguished into *superior* and *inferior;* they are articulated on each other, so as to be able to execute the motions of depression, elevation and retraction, produced by large muscles; each of them presents behind the lips a ridge, in which the *teeth* are implanted in a semicircular form; each jaw has sixteen of them, which are distinguished, by their situation and use, into incisive or cuspidated, canine and molary: and mastication is accomplished by grinding the aliments between them.

2. *Pharynx* and *Œsophagus.* These are the organs destined to transmit the aliments from the mouth into the stomach; they form a long musculo-membranous canal, which communicates above with the mouth and the nasal passages, and open below into the stomach after having crossed the diaphragm: their walls are formed by a muscular coat externally, and a mucous membrane within.

3. *The stomach.* It is a kind of reservoir more or less considerable, which forms the beginning of the intestinal canal: it is situated immediately below the diaphragm; its form resembles that of a truncated conoid; on one side it receives the inferior extremity of the œsophagus; on the other it is united with the intestines by a narrow orifice furnished by a valvula, (*the Pylorus.*) The organization of this viscus, contains on its interior a mucous membrane, on its exterior a serous membrane, and in the interval a muscular coat, some of the fibres of which are circular, others longitudinal or oblique; it receives many vessels and nerves: it is in the stomach that the principal phenomena occur.

The Intestine. It is a long canal and continua-

tion of the stomach, and ends in the anus; we divide it into several portions by beginning above, and ending below. 1. The *Duodenum*, capable of great dilatation, for this reason called *ventriculus succenturiatus;* it is in its interior that the biliary and pancreatic canals empty. Below it, we observe the *Jejunum*, properly so called; it is a cylindrical canal, the circumvolutions of which float in the abdomen and fill the greater part of this cavity. It is in its interior that the chylous absorption occurs. Next, we meet with the *larger intestine*, which contains the *cœcum*, *colon*, and *rectum*, which terminates between the nates by a narrow orifice and furnished with a sphincter. The larger intestine serves at the same time as a reservoir and excretory duct for the fecal matter. Where the ileum terminates and the cœcum begins, we remark the ileo-cœcal valve, of such a construction that when the fæces have arrived in the colon, they can no longer retrograde.

The walls of the intestinal canal are formed within by a mucous and without by a serous membrane, and in the interval by a fleshy coat, composed of circular and longitudinal and muscular fibres; these latter form three distinct bands in the larger intestine.

The interior of the digestive canal is moistened by mucus exhaled from the mucous membrane and its follicles. This exhalation is very active in the stomach, particularly at the time of digestion. It produces pretty abundantly, a grayish, viscous, and insipid fluid, named *Gastric Juice*, and to which, since *Spallanzani*, has been ascribed the power of dissolving the aliments.

In man the intestinal canal is six or seven times as long as he is high; in the carnivorous animals

three or four times only, and in the herbivorous from nine to eleven times, reckoning, however, the length of the body only from the mouth to the anus, without taking the extremities into account. These differences, arising from the nature of the aliments more or less difficult to digest, or more or less nutritive, which these animals make use of, furnish us with a new proof that man is omnivorous.

Such is the brief description of the digestive canal; but it has annexed to it several other organs, and which essentially concur in the accomplishment of the important act of digestion; these organs constitute apparatuses with peculiar functions: consequently, we shall only indicate them here; it is in the article of secretions that the details relative to them will be found. These annexed or complementary organs of the digestive apparatus are: the salivary glands and the different granulations which pour into the mouth a viscous liquid, which the aliments imbibe in the act of mastication; the amygdalæ and the follicles of the base of the tongue, the secretions of which favour the passage of the alimentary bolus at the isthmus of the fauces; finally, the pancreas and liver, which pour into the duodenum their humours indispensable to the conversion of the aliments into nutritive elements.

The gastro-intestinal canal is contained in the *abdomen,* a cavity, the walls of which, essentially muscular, powerfully concur in expelling the fæces.

ARTICLE 3.

Mechanism of Digestion.

Hunger. The want of nourishment is demanded by the necessity of obviating the waste which we

suffer at every moment; hunger, that every one knows from his own observation, is an internal sensation, which warns us of this want of our bodies; susceptible of a great number of degrees, this sensation is at first slight, and receives the denomination of appetite; afterwards it becomes violent, imperious: this is hunger, properly so called, which assumes the character of pleasure when gratified, and on the contrary that of pain when resisted.

Hunger is felt, when the stomach has been empty for some time; it is immediately arrested when aliments are introduced into it; and it is soon followed by *satiety*. A multitude of circumstances modify it in a remarkable manner; more lively in the child than in the adult, it languishes in old age; it is sometimes completely lost; it varies also according to the idiosyncrasis, the state of health or of disease, climates and seasons; lastly, according to habit, which imparts to it a regular character of periodisity. Occupations, amusements, intellectual labour and the use of opium blunt it, and even cause it to be completely forgotten.

If by circumstances or the will, we do not satisfy hunger, the stomach contracts, a tearing sensation is manifested, which causes us to be reconciled to the most disgusting food, the intellectual faculties are benumbed, every function languishes with the exception of absorption, which sucks the juices from all the parts to return them into the circulation; and hence emaciation soon follows.

Several hypotheses have been started to account for the immediate cause of hunger. *Plato* and the vitalists have ascribed it to a determination of the soul; afterwards, in the friction of the walls of the stomach, the acrimony of the gastric juice, the ten-

sion of the diaphragm, the lassitude of the stomach, the poverty of the nutritive juices, &c. have been from time to time conjured up. The sensation of hunger is evidently felt in the stomach; does it not possess a kind of intelligence or correspondence established between it and the other organs of which it foresees the wants?

Of Thirst. This also is a special internal sensation, and distinct from the preceding; it assumes, like hunger, the character of pleasure or of pain, according as it is gratified or not; like hunger, it is susceptible of a thousand different degrees, and may vary according to a multitude of circumstances. Opium, for example, which, as we have observed above, appeases hunger, excites thirst, &c.; but here habit has no longer the same influence as on hunger; nothing is determinate as to the period at which thirst returns, it manifests itself with more or less ardour, according as the want of repairing the fluid particles of the blood, is more or less urgent.

When thirst is not gratified, it becomes more and more violent, then follows a sensation of heat and dryness in the mouth, the fauces and stomach; the mucous secretion, dry up, all the organs are overheated, in extreme excitability, and inflamed; lastly, death follows in the midst of a furious delerium and the most excruciating sufferings, of which the crew of *La Méduse** offer a sad example.

* *La Méduse*, was a French frigate, which in 1815, was wrecked, whilst on her passage to India, on a shoal which was unknown to navigators; and the miserable crew, obliged to abandon the wreck, was, for a number of days, exposed to a burning sun, floating over the vast ocean on rafts, in water up to their waists, with only a little bread-stuff and even that soaked in sea-water, and without a drop of water or any thing else

As to the immediate cause of thirst, we shall say the same thing as that of hunger; it is probably produced by a similar cause. Some have located it in the pharynx, others in the stomach; but what we must not omit to mention is, that it may be allayed by injecting liquids into the veins, as Mr. *Dupuytren* has proved by his experiments.

Of the apprehension of aliments.—It is with his superior extremities, or with some peculiar instruments, that man carries to his mouth alimentary substances; in order to receive them, this latter cavity is opened by the separation of the jaws; if the opening is to be moderate, the inferior only is depressed; but when they are widely opened, we remark that the superior is carried back with the whole head. Its elevation may be reckoned nearly a fifth or a sixth of the depression of the lower jaw. *Boerhaave* ascribed this elevation of the superior jaw to a slight contraction of the exterior muscles of the head; *Ferrein* to the action of the posterior belly of the digastricus, assisted by the thyro-hyoideus muscle.—Such is also the explanation given by *Bichat* and M. *Richerand.* Lastly, M. *Chaussier* thinks that this movement is a mechanical result of the formation of the temporal maxillary articulation.*

However, the following actions occur at the time of introducing the aliments. 1. The mouth receives them passively; 2, or there is an effort made by the lips, and to this cause we must refer the suc-

to allay their thirst and moisten their parched lips in order to support their emaciated and *macerated* bodies. TRANS.

* If Chaussier's explanation means any thing, it explains nothing. TRANS.

tion by which the child seizes at first the nipple with his lips, then makes a vacuum in his mouth by a strong inspiration, and applying the soft palate to the posterior opening of the nasal passages, the cheeks and tongue assume the form of a gutter to conduct the milk into the pharynx; 3. lastly, under other circumstances, there is the action of biting in order to separate a fragment from the alimentary mass.

Of *mastication* and *insalivation.* An operation by which the aliment is triturated, softened and reduced into a kind of pulp. When the alimentary substance is introduced into the mouth, this cavity shuts by the closing of the lips and the depression of the soft palate, then the jaws begin to move, the inferior is alternately depressed and drawn near to the superior, against which it strikes as a hammer upon an anvil. The aliment always brought under the action of the teeth, by the assistance of the cheeks and tongue, is divided and torn by the incisive and canine teeth and ground by the molares. For this end, to the successive movements of depression and elevation, another, or horizontal one, is added, very well calculated for trituration.

In the meantime the saliva, the secretion of which is excited by the motion of the jaws, the contact and taste of the aliments, abounds in the mouth, and is mixed with the aliments in proportion as they are triturated, it is imbibed and converts them into a soft paste. This saturation, besides the facility which it affords to the trituration of the aliments, converts it into a paste of an easy deglutition.

In mastication, the inferior jaw presents a lever of the third order, the fulcrum of which is the temporo-

maxillary articulation, the resistance more or less near the chin, and the power represented by the temporal, masseter, and internal pterygoid muscles, in the middle. Nevertheless, in a few cases, when the aliment is placed in the plane of the insertion of these muscles, that is to say, between the molar teeth, the jaw is converted into a lever of the second order. The impulse given from below upwards, which results from the shock of the two maxillary bones, is communicated to the cranium and face through the vertical apophyses of the superior maxillary, the arbital and zygomatic portions of the molar bone; finally through the vertical part of the palatine bone.

Of Deglutition. This name is given to the passage of the aliments from the mouth to the stomach. We may, with M. Magendie, consider in it three principal actions.

1. When the aliments have been well reduced into a soft paste, it is gathered into a bolus on the superior surface of the tongue; then mastication ceases. The tongue applies its point to the roof of the mouth, and consequently it forms a plane inclined towards the pharynx; then successively contracting from its point to its base, it pushes on the aliment between it and the roof of the mouth, and forces it down the isthmus of the fauces. The soft palate then rises so as to form a continuation of the roof of the mouth, then at the same instant the base of the tongue rises, and precipitates the alimentary bolus down into the pharnyx.

2. No sooner has the bolus passed the isthmus of the fauces, than the pharynx enlarges transversly by the muscles stylo-pharyngeus, is elevated by its own muscles, and with the pharynx by the muscles of the sub-hyoidian region, which then contracting

towards the inferior maxillary, the pharynx receives its support from it; there results from this instantaneous contraction, that the pharynx being very much shortened, it carries with it the bolus, which passes with such rapidity through the whole extent of this region, that Boerhaave considered this second action as a kind of convulsion. At this moment, the alimentary bolus can not reascend into the nasal passages, because the soft palate shuts up their posterior opening; it can not re-enter the mouth, because the base of the tongue is raised; lastly, again, it can not penetrate into the larynx, because on the one hand the glottis is perfectly shut up by the operation of its muscles, and on the other, the epiglottis is lowered over it; this takes place by the simple action of the larynx being drawn up towards the base of the tongue. As soon as the bolus has arrived at the inferior extremity of the pharynx, this organ is depressed and carries it along with itself.

3. Lastly, the alimentary bolus, thrust, by the action of the pharynx, still lower down, descends gradually within the œsophagus, by the successive contraction of its circular fibres, beginning at its superior and ending at its inferior extremity; at the same time the longitudinal fibres shorten this canal over the bolus, in order to diminish the space which it has to traverse. Gravitation is not an essential cause of deglutition, but it helps without doubt the descent of the bolus; the mucus which lubricates the interior of the œsophagus, also facilitates its descent, which is however always rather slow. Finally, when it has arrived in the stomach, the inferior extremity of the œsophagus remains for some time contracted in order to prevent its regurgitation.

It is generally believed that the deglutition of liquids is more difficult than that of solids. M. Magendie entertains a contrary opinion. The deglutition of air, is at all times very difficult, and every one can not perform it; it requires great practice.

Accumulation of Aliments in the Stomach.

Deglutition successively carries down into the stomach a series of alimentary boluses; this viscous, somewhat compressed by the neighbouring organs, is by degress distended, and in proportion to the substances which are introduced into it. The contraction of the inferior extremity of the œsophagus and the narrowing of the pyloric orifice, which increase in proportion to the fulness of the stomach, detain in it the aliments. When the fulness of the stomach is considerable, that is to say, when the reservoir is completely full, hunger ceases, and it is soon replaced by a sensation of satiety and disgust. The abdominal viscera are compressed downwards; hence the necessity of making water, the diaphragm is pressed upwards, respiration is short and frequent, the belly is tense; the heat of the body seems soon after to leave the extremities, to be concentrated in the epigastric region, a slight chill is felt, which is the foreboding of the operation about to take place.

Chymification. When the aliments are accumulated in the stomach, its mucous membrane becomes very red, and is injected with a greater quantity of blood, the perspiratory and follicular secretions increase in activity, and the walls of the stomach embrace more closely the alimentary mass which they compress on all sides; in about an hour afterwards we observe, in the pyloric portion of the organ, some contractions, which soon extend to the whole

viscous; and determine an alternate movement called peristalic. These contractions, which progressively increase in energy, communicate to the aliment oscillatory movements in every direction, which facilitates its softening and its impregnation by the liquids, and particularly by the juices which ooze on all sides in the stomach; if to all this we add that the alimentary mass is exposed to a heat of at least 32 *degrees*,* we shall then have all the circumstances which concur in altering the aliments, and converting them into a homogeneous and grayish mass which is called *chyme.*

Experience has proved that chymification begins at the circumference, moving towards the centre, by very thin layers, which are successively directed towards the duodenum by the peristaltic contractions of the stomach; the pylorus opens and permits to pass those which are well digested *(chymifiés,)* on the contrary, it shuts itself up against those which are not. At every expulsion, the stomach contracts on the remainder of the aliments, and by the same mechanism gradually converts every part of them into chyme; it is a fact worthy of remark, that chymification occurs particularly within the pyloric portion.

We can not fix in a general manner the duration of this operation; it varies infinitely according to the strength and nature of the digestive organ, the degree of mastication and the quality of aliments. M. Magendie has proved by experiments that the aliments derived from the vegetable kingdom are of a slower digestion, more difficult and more incomplete. Professor Dupuytren has remarked in

* The author must mean 32° of Reaumur, although he does not mention it, which of course would make 72° of Fahrenheit. TRANS.

artificial ani, that the less rich the aliments are in nutritive principles, the more quickly they are expelled; nevertheless, generally, they seldom remain in the stomach more than four or five hours.

Physicians have not been satisfied with observing the facts which we have just related, they have wished to explain them; most of the hypotheses which have been built upon these facts are so many monuments of a truly delirious imagination.

1. The doctrine of *concoction*, suggested by Hippocrates, has been taken in all the etymological signification of the word by the physicians who have followed him, who pretended that there occurred in the stomach a true ebullition.

2. The doctrine of *fermentation* was adopted by Van-Helmont, and very much in vogue at the time when the doctrines of chyme prevailed, *(du chymisme;)* a kind of animal leven was supposed to exist in the stomach.

3. The doctrine of *putrefaction*, evidently shown to be fallacious by Spallanzani, who has proved, on the contrary, that the digestive action arrested putrid fermentation.

4. The doctrine of *trituration;* it occurs in effect in the gallinaceous animals, but it supplies with them mastication; the organization of the stomach of man rejects the admission of such an hypothesis.

5. The doctrine of *maceration* suggested and supported by *Haller*, has not survived him.

6. The doctrine of *dissolution* has generally been ascribed to Spallanzani. The stomachic digestion, according to him, is the result of the dissolution of the aliments by a particular juice denominated *gastric*, and which, he says, accumulates in the stomach whilst empty. This naturalist pretends to have

produced artificial digestions by saturating well masticated aliments with this gastric juice, taking care to keep up, in the whole mass, a proper degree of heat. This doctrine has been admitted by a great number of physiologists, Viridet, Hunter, Dumas, Richerand, &c. but none agree as to the *source* whence it comes, nor on the *nature of this humour*.

Many are the adversaries of this doctrine; *Demontégre* particularly, who possessed the faculty of vomiting at pleasure, has convinced himself that the juice which the stomach contains, whilst in an empty state as to aliments, is nothing more than saliva, which has often acquired a certain degree of acidity by a certain degree of digestion. M. Chaussier positively denies the possibility of the artificial chymification of *Spallanzani*, as well as the accumulation of gastric juice in the stomach: he simply thinks that, during digestion, the excitation produced by the aliments on the gastric mucous membrane induces an abundant oozing of juices calculated to produce chymification; let us observe, that to these juices is superadded the saliva, the mucous of the mouth, pharynx, and œsophagus, drinks, and a certain quantity of atmospheric air.

Nervous influence has a great share in the action of chymification, as demonstrated, in an indisputable manner, by the experiments of *Baglivi*, Le *Gallois*, De *Blainville*, *Dupuy*, *Hastings*, Dupuytren &c., who have divided or tied the parvagum. From more recent experiments, performed on the same subject by *Wilson Philip*, and repeated since by Messrs. *Breschet*, *Edwards*, and *Vavasseur*, in order that chymification may be completely suspended, it is necessary that the extremities of the divided

nerve be at a distance from each other; an extremely remarkable fact—observed by these experimenters, is, that we may re-establish digestion by supplying the nervous influence by a galvanic current. Does electricity act the same part in the animal economy as in chymical combinations?*

However, by the joint action of the stomach, of the numerous juices which abound in this cavity, of the animal heat and of the nervous influence, the alimentary mass, whatever besides may be its nature, is reduced into chyme. This is a grayish and viscous matter, of a sweetish taste, which mostly has been found acid, and sometimes alkaline. M. Marcet, who recently has made an analysis of it, has found in it some albumen, an animal matter, and some saline particles which consisted commonly of lime; he has found it a little different, according as it was the produce of a vegetable or animal diet; in the latter case, it always contained less carbon. It is very probable that its nature varies in the same manner as the alimentary substances: in the stomach of a man who died suddenly, some time after having taken milk, in an epileptic fit, Messrs. Lassaigne and Leuret found in the chyme, lactic acid, sugar of milk, albumen, an acid, yellow and fatty matter, another substance resembling cheese, muriate and phosphate of soda, and phosphate of lime.

* I can not forbear mentioning here the very valuable and ingenious "Physiological Essay on Digestion," by my friend Dr. N. R. Smith, professor of surgery in the university of Maryland. This memoir contains numerous facts, derived from *anatomy* and *physiology*, sufficient to shake our faith in *gastric juice*. It is very well worth the perusal of every student of medicine. TRANS.

Accumulation of chyme in the duodenum.

As soon as the chyme is elaborated by the stomach, it successively passes into the duodenum, in which it gradually advances as another flux enters; this intestine is dilated and the chyme accumulates in it; the construction of the pylorus prevents it from regurgitating back into the stomach, and although nothing prevents its entering into the jejunum, it commonly enters only after having undergone a new elaboration.

Chylification. When chyme arrives in the duodenum, it excites in it a concentration of action; the mucous membrane is injected with a greater quantity of blood, the perspiratory and folliculary secretions augment in activity, the excitation is extended to the *ductus communis choledochus* and pancreatic duct, and immediately determines an afflux of a considerable quantity of bile and pancreatic juice; these humours continually mix with and penetrate the chymous mass. This impregnation is gradually produced from the exterior inwards, is besides facilitated by the peristaltic contractions, which slowly move on the matter in the intestines.

As soon as the chyme is impregnated with bile and pancreatic juice, it experiences a great alteration: it assumes a bitter taste and yellow colour; if it is derived from fatty matter, we observe, as M. Magendie remarks, filaments formed on its surface quickly attaching themselves to the valvulœ conniventes of the small intestines; they are, according to this experimenter, *imperfect* chyle (*chyle brut*). In every other case, the chymous mass is covered over with a grayish semi-fluid layer, which adheres to the intestinal mucous membrane; this new matter

has neither the appearance nor the composition of chyle, but without doubt it contains the elements of it.

Such are the phenomena which we observe during the particular elaboration which converts the chyme into chyle; if we wish to penetrate more deeply into the mystery of this action, we are involved in a profound obscurity which paralyses our senses, and reduces us to the vague conjectures of the imagination. All we positively know, is, that the chyle is only prepared by the mixture of the chyme with the bile and the pancreatic juice; and, nevertheless, we shall see that Messrs. Lassaigne and Leuret even deny, to a certain degree, this position. In a memoir which they have just read at the institute, they consider stomachic digestion simply a dilution of the aliments by the acid gastric juices. They have always met with chylous molecules already formed in the mammiferous animals; they have even obtained some of them in the artificial digestions of *Spallanzani*. They believe that the bile only facilitates their formation by thinning and dissolving the substances which had not been so by the action of the gastric juice; finally, after applying a ligature on the ductus communis choledochus, they have observed chylification to continue. It is well known that Brodie had obtained a contrary result.

The ancients considered bile as a soap proper to unite closely the fatty particles with the watery parts of the aliments. Boerhaave says that it is well calculated to blunt the acidity of the chyme. M. Chaussier thinks that it is destined, with the other juices, to produce the dilution of the aliments and to separate them into chyle and fæces. It is now

thought that bile separates itself into two parts; the one alkaline, which is united to the chyle, the other acrimonious and bitter, which is united to the excrements; as to the pancreatic juice, some ascribe to it the property of precipitating the alkali of the bile, others think that it serves only to dilute cystic bile.

Chyle, considered in itself, is a fluid of a milky whiteness, transparent in the herbivorous animals, and opaque in the carnivorous; of a sweetish taste, of a spermatic odour; it divides itself, like the blood, into two parts, one sero-albuminous, the other the coagulum, (*caillot*) consisting of fibrine of a colouring matter, and moreover of a fatty substance. According to M. Marcet, that which is derived from vegetable aliments, deposits a residuum or clot almost colourless, putrefies slowly; when distilled, gives out a little sub-carbonate of ammonia, and contains more carbon; whilst that which is afforded by animal diet deposits an opaque and rosy coagulum, it quickly putrefies, furnishes a great deal of sub-carbonate of ammonia, contains less carbon, and is covered with a fatty matter which the other does not possess.

Passage of the chyme into the jejunum, and absorption of chyle.

In proportion as the chymous substances journey on into the jejunum, they induce the peristaltic contraction of this canal, and a more abundant mucous secretion, which favours their progress. During their passage they experience gradually the change of which we have spoken, and the grayish, semifluid and exterior parts, are absorbed by the chylopoetic vessels with which they are in contact; this

very active absorption, and of which we shall speak more particularly hereafter, (*see absorption*,) concentrates more and more the chyme, in depriving it of its nutritive principles, so that when it arrives towards the lower extremity of the ileum, its consistency is very much increased, whilst its chylous layer disappears; in a word, it is reduced into an excrementitious residue.

Action of the larger Intestine. It is by the same peristaltic motion, that the lower cxtremity of the jejunum induces the alimentary residue to penetrate into the cœcum; the ileo-cœcal valve is formed, as we have already remarked, so as to permit a free passage, and to prevent entirely any retrogradc movement; the fæces necessarily accumulate in the cœcum, as well by its low situation as by the extension of its cavity; but after having remained for a certain time, their presence cxcites the contraction of this kind of reservoir, and in such a manner that thc excrement is directed towards the colon; this latter in its turn also contracts, and forces on the fœcal matter down into the rectum, where it is accumulated; the mucus with which the mucous surfaces are besmeared facilitates this progression.

During thcir course in the larger intestine, the fæces are deprived of their more fluid parts, and acquire a consistency and more or less fetor. M. Adelon admits also that at this period a new change occurs in the alimcntary substances; but most physiologists think that it is a simple condensation of thc chymous residue.

The analyses which have been made of the stercoreous matter by Messrs. *Berzelius*, *Vanquelin* and *Thenard*, have given water, albumen, vegetable and animal remains, some bile, animal matter,

siliceous matter, some sulphur and several salts. The excrements are commonly accompanied, in the larger intestine, with several gases: azote, carbonic acid, the sulphureted and carbonated hydrogen, &c.

Defecation. The rectum is very dilatable, and permits the fœcal matter to accumulate in considerable quantities; its sphincter, besides, which is almost entirely under the influence of the will, hinders its escape, and exempts us from the necessity of passing it at every moment. Whilst it remains in the rectum, the stercoraccous residue acquires irritating properties; besides augmenting continually in quantity, it incommodes by its weight and volume, and becomes a hindrance to the normal exercise of the neighbouring organs; hence it produces in us a sensation which demands its expulsion; this sensation soon becomes imperious and removes every opposition of the will.

In order to satisfy this call of nature the body assumes a convenient position: sometimes seated on a close stool, at others squatted down and bent forward; then, the rectum, the sensibility of which is exalted, begins to act, its longitudinal fibres slightly contract to diminish its length, whilst its circular fibres contract throughout, beginning above and terminating below, and thus press upon the stercoraceous cylinder; in the mean time the sphincter relaxes, the muscles of the abdomen conjointly with the diaphragm, which is depressed by a strong inspiration, compress the abdominal viscera over the rectum, the levater ani and coccygeus, support and render it tense; then the excrement, compressed on all sides, is expelled through the anus, in which the fæces are moulded and assume their well known form. During this effort, Hallé has remarked, that the

mucous membrane prolapses under the form of a circular ring, which is withdrawn after defecation.

Of anormal digestive excretions.

In a normal state the digestive functions occur as we have already described, consequently every thing which departs from this natural state ought to be considered as morbid; but nevertheless man is often exposed to accidental excretions, which are commonly classed with physiological phenomena. We shall examine them briefly.

1. *Eructation.* When any gas is contained in the stomach, it necessarily occupies the superior region, from its specific gravity; the inferior extremity of the œsophagus being contracted, it prevents the gas from ascending into this tube; but if, by any cause this obstacle is removed, it immediately enters into it, and escapes through the mouth, producing a noise which is caused by the vibration of the margin of the pharynx, communicated by this gas. If it is accompanied with vapours or liquids, the eructation assumes the name of *a rising.*

2. *Regurgitation.* It is a phenomenon similar to the preceding; it differs only that instead of gas, liquids or aliments are ejected. Regurgitation with many persons is involuntary; however, there are individuals who produce it at pleasure, and after their meals, exercise this faculty to produce a kind of rumination. This happens particularly when the stomach is over distended; nevertheless we also observe it, when it contains mucus only; its mechanism is the same as that of eructation; but in the individuals who produce it at pleasure, we observe at first that they make a deep inspiration in order

to compress the diaphragm over the stomach: perhaps they swallow a certain quantity of air; they afterwards contract the abdominal muscles on this viscus, which they compress at the same time with both hands; then the aliments reascend into the mouth: the stomach without doubt does not remain passive.

3. *Vomiting.* This name is given to the convulsive excretion, through the mouth, of the substances contained in the stomach, and sometimes from other parts of the intestinal canal.

Nausea. Under the influence of a disagreeable impression of the senses, of a titillation of the soft palate, of the presence of irritating substances in the stomach, of the distension of this viscus, of the ingestion of emetics, &c. &c. a peculiar and indescribable sensation is induced, which every one knows from his own observation, and which is commonly called *nausea.* This sensation is generally referred to the stomach; but we are entirely ignorant as to the particular part in which it is located.

Mechanism of vomiting. To the sensation which warns us of the necessity of vomiting soon succeeds a contraction of the stomach and abdominal muscles; then the substances contained in this viscus surmount the obstacle opposed by the cardiac region, and are thrust into the œsophagus; their presence instantaneously excites the contraction of the fibres of this canal, but in an inverse order from that of deglutition; in this manner they re-ascend into the pharynx: from this moment this latter cavity convulsively contracts, the glottis shuts up, the soft palate rises and assumes an horizontal station, the pharyngian cavity is gradually dilated, a great abundance of saliva is poured out, the mouth is

widely opened, the head is a little bent forward over the chest in order to shorten the pharynx, then the ingesta are briskly thrust out, and often to a considerable distance: the same effect is produced commonly several times, respiration is suspended, the face is reddened, and tears are abundantly shed.

Such are the phenomena that we observe in vomiting; but what is the active cause of it? the ancients ascribed it to a convulsive contraction of the stomach directed from the pilorus to the cardiac extremity. *Bayle* at first, and *Chirar* afterwards, after some experiments, came to the conclusion that vomiting resulted almost exclusively from the compression of the stomach by the abdominal muscles. *Haller* advocated the ancient doctrine. M. *Magendie* revived the opinion of *Bayle* by a series of ingenious experiments; for example, he supplied the stomach of a dog with the bladder of a hog half full of water; he united the parietes of the abdomen; he afterwards injected tartar emetic into the veins, and vomiting ensued; on the other hand he paralyzed the diaphragm by cutting the phrenic nerves, then he removed the abdominal muscles; when he found that vomiting could not take place, &c. &c. In all these experiments M. *Magendie* remarked the animal swallowing air, probably in order to distend the stomach, and facilitate its compression by the muscles which produce vomiting. M. *Maingault* attempted some new experiments, which led him to contrary results from those of M. *Magendie*, and consequently to consider the stomach as the only active agent in vomiting; finally, the new researches of *Béclard* and of professor *Richerand*, have brought back most physiologists to the opinion of

M. *Magendie.* However, the experiments of M. *Maingault* leave the question as yet unsettled.*

Digestion of Liquids.

The digestion of liquids presents very few peculiarities: arrived in the stomach, they are mixed with its mucus, they become troubled, and their temperature soon equalizes itself with that of the organ; in a very short time they completely disappear; absorbed immediately from the stomach, they pass into the smaller intestines only when they exist in great quantity; if they contain any alimentary particles, these latter are *chymified* and undergo the different digestive alterations which we have already described.

* Who shall decide when such great observers disagree, and thus come to opposite conclusions? I think we may draw the same conclusion from this difficult point, as from the favourite doctrines which have prevailed from time to time, concerning the phenomena of digestion, that some of the opinions, here entertained on this subject, are erroneous, and that the others are partially true; because nature has never left, entirely, the performance of any particular and vital function, to one exclusive individual organ or action, but to a system of organs or apparatus, all concurring to the same end; so that, in case any part of the apparatus should, by any morbid cause, be unable to perform its office, its place might be easily supplied by the other parts of the same apparatus: For example, if either the diaphragm or abdominal muscles be paralysed, or both, the stomach might supply their want by greater efforts in its contractions, and vice versa. In this manner, I believe, that all the discrepancies existing between the opinions of these great men may be reconciled, and it seems to me the only way to form a correct opinion from such contrary experiments and results.

TRANS.

CHAPTER II.

Of Absorption.

The immediate object of this function is to gather either externally or within the structure of our organs, and to elaborate, by means of particular vessels, different materials destined to repair the deterioration of the blood.

Absorption is divided into *external* and *internal;* the former is the digestive, the latter is the lymphatic absorption; we shall successively treat of each of them separately.

ARTICLE 1.

External, or Digestive Absorption.

1. *Chyliferous apparatus.* This name is given to a collection of peculiar vessels situated between the two laminæ of the mesentery, which extend from the smaller intestines to the *receptaculum chyli;* (*reservoir of Pecquet*) crossing in their passage a great number of small bodies called mesenteric ganglia.

According to *Cruikshank, Hewson, Hedwig,* &c. these vessels spring immediately from the free surface of the mucous membrane; they pretend to have distinctly seen their orifices; or, on the contrary, according to *Rudolphi, Meckel, Cuvier,* &c. they spring

from a soft and spongy substance, susceptible of imbibition, which covers the interior of this mucous membrane. However, these vessels, extremely minute and numerous, are at first situated on a circular line between the villous and muscular membranes, where they form a very fine net work; hence they direct their course between the two laminæ of the mesentery, and cross two or three rows of mesenteric ganglia, before reaching the receptaculum chyli, in which they terminate in several large trunks.

The chyliferous glands are very numerous, their number increases as they are further removed from the intestine; irregularly lenticular, and of a delicate rose colour, they are most generally considered as the result of an assemblage of chyliferous vessels. Some anatomists admit small cells between the *afferens* and *efferens* vessels.

The structure of the chyliferous vessels is composed of an external fibrous membrane and of a very thin internal one, which presents within small valvular folds.

2. *Mechanism of chylous absorption.* For the same reason that the formation of the orifices of the chyliferous vessels is as yet unkown, we are entirely ignorant in what the action of absorption consists. Nevertheless, these vessels evidently possess a peculiar action, by virtue of which they suck from the chyme the elements of a new fluid, as is demonstrated by the formation of the chyle; but in what does this absorption consist? It has by turns been ascribed to the compression of the chyle by the intestinal parietes, which forces it to enter into their gaping orifices; to the capillary attraction of the mouths of the chyliferous vessels; to a special sensibility joined to an organic contractility of the

absorbing orifices, &c. A very curious circumstance, worthy of being noted, and which was observed by M. Magendie is, that this absorption continues some time even after death.

Of the progression of Chyle. Chyle, whatever may be the mechanism of its absorption, flows throughout the chyliferous vessels, traverses the ganglia which it meets with on its passage, and at last arrives in the thoracic canal, together with the lymph; the causes which induce its flow, are 1, the continuity of absorption; 2, the tonic action of the vessels themselves; 3, the pressure of the abdominal viscera by the respiratory movements; 4, lastly, the throbbing of the neighbouring arteries. It is impossible to give a correct calculation of the motion of the chyle, because very probably it varies according to several circumstances. M. Magendie, for example, who has made experiments on this subject, observed at first, that the progression was generally slow, and that it was more active when the aliments abounded, and were of an easy digestion. We might also conclude from this observation, that this progression is the less rapid as it approaches the more inferior extremity of the smaller intestines; and according to the law of the progressive motion of liquids in tubes of different diameters, chyle ought to flow more slowly, in proportion as it approaches the thoracic canal.

A great number of observations and experiments, go to prove, that the chyle is elaborated throughout the extent of its progress, and gradually becomes more and more animalized. At first white and serous, it becomes rose coloured and *fibrinous.* Messrs. *Emmert*, *Tiedmann*, and *Gmelin*, assert that before crossing the ganglia it is white, and does not become red by the contact of the air; that it

scarcely coagulates at all, and only deposites a yellowish pellicle; that, on the contrary, when it reaches the receptaculum chyli it is rosy, coagulates entirely, and deposites a cruor of a scarlet colour. This elaboration of chyle is generally ascribed to the mesenteric ganglia; but physicians do not agree on the mechanism of their action, and all that has been said on the subject, sufficiently proves that we know nothing about it. Recently, Messrs. *Tiedmann* and *Gmelin* have advanced that the spleen concurs in the act of chylification, in preparing a coagulable fluid proper to animalize the chyle in mixing with it in the thoracic duct.

Absorption of liquids. In treating of digestion, we have seen that liquids disappear with such rapidity from the stomach, that very often they do not reach even the intestines. Now as the chyliferous vessels do not exist in the stomach, there are necessarily some of another kind, which produce absorption. Before the discovery of the lymphatic and chyliferous vessels, the ancients considered the veins as the only organs of every kind of absorption. This doctrine was afterwards generally forgotten, and all the digestive absorptions in particular, were ascribed to the chyliferous vessels; such is still at the present time, the opinion of most physiologists. But more recently Messrs. *Ribes* and *Magendie* have revived the opinion of the ancients, and think that liquids are absorbed by mesenteric veins; on the one hand they have remarked, injections thrown into the vena portarum to issue into the intestinal canal, as it had been also remarked by *Lieberkun*; on the other, they have, in well-performed experiments, always found in the mesenteric veins, coloured or fragrant liquids; that they had injected into the digestive canal of several animals, without

being able to discover the least trace of them in the lacteal vessels; finally, they call upon the authority of *Boerhaave*, who asserts that he had seen the blood in the mesenteric veins, become more fluid during the digestion of liquids; and on that of *Flandrin*, who has remarked that this blood in horses preserved the smell of the herbs on which they had fed. In conclusion, it seems very probable that the absorption of liquids is performed by the veins, at least in a great measure.

ARTICLE 2.

Internal or Lymphatic Absorption.

The object of this function is to suck up from every organ a peculiar juice, known under the name of lymph, and carry it into the sanguiferous system. There exists in the history of this kind of absorption, the greatest obscurity, as well in reference to its agency as to its mechanism.

First, which are the vessels that produce the internal absorptions? Since the discovery of the lymphatic vessels, they are generally considered as the exclusive agents of this function; but recently, the venous absorption, stated by the ancients, has been revived by Messrs. *Ribes* and *Magendie*, and who particularly ascribe to it the internal absorptions; from that moment, violent debates have arisen between the partizans of these two doctrines, and in the midst of all these debates, nearly as profitable on the one side as on the other, most physiologists remain in doubt, and admit provisionally the lymphatic and venous absorption.

These two kinds of vessels, are in effect spread from the surfaces in which the absorptions occur, to

the circulatory centre: their origin, in the parenchyma of the organs, seems to be the same; the fluids which they contain, go in the same manner into the lungs in order to be converted into arterial blood; finally, the materials of anormal absorptions are to be met with in both cases. For, if physicians have often met with morbid humours in the veins, we may oppose to this the observations of Messrs. *Desgenettes* and *Sœmmering*, who have remarked some bile in the lymphatics of the liver; that of M. *Dupuytren*, related by M. *Cruveilhier*, in which pus was found in the lymphatics, near a tumour in suppuration, &c.

1. *Apparatus of internal absorption.* It is composed of an assemblage of vessels, very numerous and very minute; which extend from every part of the body,* to the centre of circulation. These vessels, named *lymphatics*, are distributed into two sets in almost every organ; the one superficial, the other deep: their origin is invisible and unknown; some anatomists admit between them and the arteries a direct and immediate communication; others think that they open by a gaping orifice on the surfaces and into the structure of the organs. *Lieberkun* asserts that at their extremity is met a small spongy vesicle in which terminates an artery and a vein; however, as soon as they are perceived they are observed to increase in bulk, to anastomose again and again with each other, so as to form net-works in every part of the body, particularly in the serous and tegumentary membranes; lastly, they gradually leave their point of origin, traverse several series of

* As yet none have been discovered in the encephalon, the spinal marrow and the eye.

ganglia which they meet with in their progress, and unite at last in two principal trunks: the one, the thoracic duct, which receives at the same time the chyliferous vessels, and which is situated in front of the vertebral column and opens into the left subclavian vein; the other, much smaller, is the right lymphatic trunk, which terminates in the same vein, but of the right side.

A multitude of ganglia intercept the progress of the lymphatic vessels; they are generally larger in proportion as they are nearer the common trunks: their form is rounded or elongated; they are covered by a small membrane very vascular. *Haller*, *Albinus*, *Hewson*, *Meckel*, consider them as being the result of a kind of clustering of lymphatic vessels *(pelotonnement;) Malpighi*, *Nuck*, Hunter, *Cruikshank*, assert on the contrary that these vessels are here interrupted by small cells.

The structure of the lymphatic vessels is to all intents and purposes the same as that which we have described while treating of the chyliferous vessels; they are furnished with a multitude of valvulæ.

Lastly, we shall also reckon the venous system among the agents of internal absorption; but it shall be described hereafter. (See *circulation.*)

2. *Mechanism of the lymphatic absorption.* The mechanism of this function is rather inferred by the observation of its result, than by any positive knowledge of it; this function indeed is in itself inscrutable, so that we can only offer conjectures on it. The materials on which this function acts are, 1st. the molecules which are derived from the decomposition of the organs, which constitutes the *interstitial absorption of John Hunter*; 2, the recre-

mentitial secreted juices, serosity, synovia, and particularly fat, the absorption of which is so active during abstinence &c; 3, finally the thinnest parts, the most assimilable of the excrementitial products.

To say that the absorbent action of the lymphatic vessels is still more obscure than that of the clyliferous vessels, is to announce beforehand that it is entirely unknown. All the hypotheses which have been imagined to account for the one have been applied to explain the other; thus they have tried to explain it, 1, by the influence of a pressure which forces the lymph to penetrate into the wide open orifices of the lymphatics; 2, the capillary action of the lymphatic radicles; 3, a kind of erection or alternate movements of contraction and dilatation of their extremities; 4, the passive imbibition of a kind of spongy substance in which it is supposed these vessels arise, &c.

Whatever may be the mechanism of this absorption, the action of the lymphatic vessels is not confined to the collection of the materials just enumerated, but it effects an especial alteration which converts them into lymph. This humour seems not to be altogether formed in the parenchyma, or at the surface of our organs; it is true however that the ancient physiologists considered it as the white and serous part of the blood, and such is still the opinion of some modern authors, who deny the absorption of the lymphatic vessels.

3. *Progression of the lymph.* This humour moves on through the lymphatic vessels and ganglia, from their origin to their termination in the two sub-clavian veins, by a mechanism precisely like that of the progression of chyle. The causes which communicate this movement to the lymph

are, 1, the continuity of the absorption; 2, the tonic action of the vessels themselves; 3, the pulsation of the neighbouring arteries; 4, and finally, the contraction of the muscles; or the motion given to the surrounding parts. *Malphigi* considered the ganglia as so many little hearts, or active powers, placed at different distances along the vessels to excite in them the circulation. According to the remarks of *Sœmmering* and of M. Magendie, the progress of the lymph is extremely slow, but we are ignorant whether it be uniform throughout the lymphatic apparatus.

Lymph is a viscous fluid, slightly milky, not of a well defined odour or taste; it is divided into two parts, one liquid, like to the serum of the blood, the other solid, composed of fibrinous and reddish filaments. *M. Chevreuil* has found in it some water, fibrine, albumen, muriate and carbonate of soda, phosphate of lime and phosphate of magnesia.

4. *Mechanism of venous absorption.* Many physiologists maintain that venous blood is only the remainder of the arterial blood; that there is a direct communication between the arterial and venous systems; finally that this latter system does not absorb. But, first, venous blood is more abundant than the arterial, consequently it contains something more than the residue of this latter; second, all that we have already observed, and the beautiful experiments performed by M. Magendie on the subject, establish in a manner beyond doubt venous absorption.

The materials on which this absorption acts are the same as those that we have indicated for the lymphatic system; as to the mechanism of absorption, it is without doubt the same as that of the lymphatic

vessels; it is enough to say that we are utterly ignorant of it. M. *Magendie*, in a memoir read at the Institute, establishes that this absorption occurs by capillary attraction. Still more recently in a special memoir, M. *Fodira* presumes that this action is only an imbibition. The *circulation* of the venous blood will be treated elsewhere. (See circulation.)

Venous blood, exposed to the air, coagulates and disengages a considerable quantity of carbonic acid; it separates into two parts, the serum and the crassimentum: 1, the serum is a yellowish liquid, slightly viscous and alkaline. M. Marcet has found in it some water, albumen, or muco-extractive matter, muriate of soda and potass, sub-carbonate of soda, sulphate of potass, phosphate of lime, iron and magnesia. 2, The crassimentum is a spongy mass of a reddish brown, which separates by being washed in water into fibrine and cruor, that Messrs. *Brande* and *Berzelius* consider as an animal matter combined with peroxid of iron.

All that we have just said on external, as well as internal absorptions, applies equally to morbid absorption. Their mechanism being the same, it becomes therefore superfluous to treat of them in particular.

Here ends the subject of absorption; in their history we have acquired a perfect knowledge of the materials, which, in the following function, will be converted into nutritive fluids or arterial blood.

CHAPTER III.

OF RESPIRATION.

The different fluids which are collected on all sides by the absorbents are the only restorative materials of the economy; but before becoming positively nutritive, they require the intervention of a special function, which converts them into arterial blood, by combining with them a new element: such is the immediate end of respiration.

ARTICLE 1.

1. *Atmospheric air.* It is an elastic, colourless, permanent, compressible fluid, which forms round our globe a structure of sixteen or seventeen leagues high. It is indispensably necessary for the existence of all organized beings, to whom it furnishes one of their constituent principles (*oxygen*). It will suffice to recall here its composition in order to be able to appreciate the part which it performs in the act of respiration. Atmospheric air is composed of 21 parts of oxygen, and 79 of azote; it contains besides a small proportion of carbonic acid, water, and holds different foreign substances in suspension, and independently of all this, it contains caloric, light, and electricity.

ARTICLE 2.

2. *Respiratory apparatus.* The lungs are the immediate instruments of respiration; they are two extensible, spongy and vascular organs, situated in the latteral parts of the chest which they fill up completely; separated from each other by the pericardeum and the heart, they are united by an aerian canal. The one on the right side is divided into three well marked lobes; that of the left side into two only.

The organization of the lungs contains, 1, the bronchiæ, which form the essential part; they proceed from the trachea, and ramify infinitely to form the parenchyma of the organ; according to *Malpighi*, they terminate in vesicles. *Helvetius* supposes that they freely open into the areolæ of the cellular tissue. *Willis* compares the bronchic extremities to a bunch of grapes. *Reisscissen* has observed them to terminate in a round cut-de-sac, &c.; 2, An artery called pulmonary, which accompanies the bronchiæ through every division; it forms, by its ramified extremities according to *Malpighi* and *Reisseissen*, a *rete admirabile* over the bronchic vesicles. Other anatomists think that their last ramifications communicate directly with the pulmonary veins, the exhalent vessels and the bronchiæ. *Bichat* admits an intermediate capillary system. What is very certain is, that the injections pass from the arteries into the veins and bronchic tubes; 3, the *pulmonary veins*, the formation of the last ramification of which is no better known than that of the arteries; 4, There are *bronchic arteries* and *veins*, *lymphatic vessels* and *nerves* for the nourishment of the organ; 5, a lamilated cellular tissue

which unites all these parts into lobules, successively becoming larger; 6, finally, a serous membrane, the *pleura*, envelopes the whole organ:

The lungs exactly fill the cavity of the pleuræ, as it has been demonstrated by *Haller*, *Sauvages*, *Caldani* &c.; and since on the other side they communicate freely with the external air, they necessarily follow every movement of dilatation and contraction of the chest.

The form of the thorax is a hollow conoid, the moveable parietes of which fulfil with respect to the lungs the office of a pair of bellows. Its bony frame is formed behind by the dorsal vertebræ, before by the sternum, and on the sides by the ribs; these different bones are articulated in such a manner as to move upon each other. A great number of muscles complete the parietes of this cavity; they may be distinguished according to the movements which they produce, into inspiratory and expiratory muscles. It is from their alternate action that the mechanism of respiration results.

ARTICLE 3.

Mechanism of Respiration.

It comprehends, 1, the sensation of the want of respiration; 2, the muscular action which produces the inspiration and expiration; 3, lastly, sanguification.

1. *Want of Respiration.* No word can indicate this want, it is a special internal sensation, very distinct in its end. At first it has a pleasurable sensation; but if not gratified it becomes painful, and forcibly urges us to perform the action that it

provokes; if any obstacle hinders us from satisfying it, asphyxia follows.

This sensation is felt as soon as the air introduced into the lungs has been expended; say from sixteen to twenty times in a minute; twenty-four times according to *Davy;* nineteen according to *Thomson;* the medium 28800 times a day for a man of ordinary size.

2. *Inspiration.* This name is given to the movement by which the chest augments in capacity, and draws the air into the lungs. The dilatation varies according to the number of muscles which are engaged in performing this action. In short inspirations, the two muscular portions of the diaphragm are depressed, and compress the abdominal viscera; consequently the vertical diameter of the chest is enlarged. When the inspiration is fuller, besides the preceding movement, which always occurs, there is an enlargment of the transversal and antero-posterior diameters; in order to produce this result the ribs must necessarily be elevated.

Haller and *Bichat* consider the first rib fixed by the scaleni muscles, which serves as a point of support on which the intercostal muscles successively elevate the ribs. *Hamberger* presumes that the internal intercostals are expiratory muscles; he relies for his opinion on their direction. *Sabatier* asserted that the superior ribs were elevated, the inferior depressed, and the middle ones carried directly outwards. M. *Magendie* assures us that the first rib has the greatest extent of motion; he grounds his opinion on the fact that its head is only articulated with a vertebra, that it has no inter-articular and costo-transversal ligaments, and that, by contrary reasons, the ribs must be less and less moveable in

proportion as they are lower down. M. *Bouvier* agrees with M. *Magendie*, who thinks that the first rib is the most moveable, and that the chest rises as a whole, but in equal degree throughout.

Finally, in deep inspirations to these motions, is added the action of the pectoral muscles, the latissimus dorsi, the serratus &c.; then the dilatation has all the extent possible; the anterior extremity of the ribs, raised and brought forward, press the sternum forward, and communicate to it a movement of elevation which is somewhat greater below. So that this bone appears to perform a slight tilting or oscillatory motion.

We have said, in opposition to the opinion of *Van-Helmont*, *Vepfer*, *Mascagni*, &c., that there was not the least particle of air in the cavity of the pleura; consequently the dilatation of the chest must be immediately followed by that of the lungs. In effect, the glottis, at the moment of inspiration, opens, as has been demonstrated by *Le Gallois*, and the air suddenly precipitates itself into these organs, and remains in them some time before being rejected. We are ignorant if it be distributed at the same time throughout the whole extent of the lungs, or into some lobes only; if it goes at once into the smallest bronchic ramifications, or if its activity be diminished by that which had not been expelled in the preceding expiration.

The quantity of air that penetrates into the chest during an ordinary inspiration, has been reckoned at 12 cubic inches by *Goodwin*, at 2 according to *Gregory*, from 16 to 17 by M. *Cuvier*, and at 15 by *Borelli;* this naturalist supposes that for that purpose the power of the inspiratory muscles is equal to a weight of 32040 pounds.

3. *Expiration.* An internal sensation, an unpleasant feeling, a kind of smothering or suffocation soon warns us that the air can no longer remain in the lungs, and imperiously demand its expulsion.

Immediately after, the power which had enlarged the thorax ceases to act, and this cavity resumes its former capacity, the diaphragm relaxes and reascends into the chest, the abdominal parietes compress the viscera; the ribs having been elevated, are mechanically depressed by the relaxation of the inspiratory muscles, and perhaps also, as it was presumed by *Haller*, by the elasticity of the costal cartilages, which having experienced a slight twisting, tend to return to their natural state. Lastly, in deep expiration, the abdominal muscles, such as: the rectus abdominis, the quadratus lomborum, the sacro spinalis, the serratus minor inferior, the triangular of the sternum, contract and bring back the ribs forcibly downwards.

However, the air, according to the ingenious comparison of *Mayow*, is expelled from the lungs in the manner of a pair of bellows when its boards are drawn together. Nevertheless, some physiologists think that the lungs play an active part in this action; which is very doubtful, for we have already remarked that they can not leave the thoracic parietes.

The quantity of air which is expelled from the chest is less than that which is taken in, by two to four cubic inches according to M. Cuvier; by a fiftieth part only according to other experimenters; however deep the expiration may be, there will always remain in the lungs 1786 cubic *centimetres* according to *Goodwin;* 1933 cubic *centimetres* according to *Davy;* from 60 to 100 cubic inches ac-

cording to M. *Cuvier*. But for physiologists these results must vary infinitely, according to age, sex and constitution; so that they must be considered as individual results and can not be generalized.

The movements of inspiration and expiration, succeed each other without interruption from the moment of birth till death. M. *Adelon* thinks that this succession entirely depends on the will, since both these movements depend upon it, and that habit produces them almost irresistibly; but at the same time that he refutes the hypotheses more or less fanciful, which have been imagined in order to explain this phenomenon, he substitutes in their place an opinion no less untenable. First, the influence of the will over the respiratory movements, although very extensive, is, however, limited. Is it at the will of the child just born, that his respiration assumes an order which it must preserve all his life? Where is in him the great influence of habit? On the other hand, is it probable that mere habit can sustain a function so active during sleep, and a multitude of other circumstances in which the will is annihilated? The will, without doubt, has a very great power on the muscular action of this function; but I believe that we must not seek in it the immediate cause of the successive movements of dilatation and contraction of the chest.

4. *Sanguification* or *Hæmatosis*. The essential object of respiration is to convert into arterial blood the fluids of absorptions, the chyle, lymph and venous blood; these humours arrive from all sides in the right ventricle of the heart, are sent by it into the parenchyma of the lungs, where they consequently come in contact with the atmospheric

air, in the condition that we know already they possess.*

Before entering into the theories of their change into arterial blood, let us first examine what is the ground on which they repose

1. *Alteration of the air.* First, it is incontestable that the air parts with a certain quantity of oxygen; say thirteen parts in eighteen according to *Goodwin,* a fourth only according to *Meuzies;* from three to four hundredths according to Messrs. *Davy* and *Gay-Lussac.*

Secondly, *Bertholet, Nysten* and M. *Dulong* think that it takes up a little azote; whilst *Spallanzani, Allen* and *Pepys,* and Messrs. *Humboldt* and *Davy,* suppose that there is on the contrary a small quantity absorbed. Some recent experiments of M. *Edwards* go to prove that these two effects can occur; but that in the ordinary condition, this gas takes no part in the act of respiration.

Thirdly, the expired air brings out with it some carbonic acid; eleven hundredths parts according to *Goodwin,* five according to *Meuzies,* three according to M. *Gay-Lussac.*

Fourthly and finally, the air is charged with a great quantity of humidity, which has been reckoned at 560 drachms by *Lavoisier* and *Séguin,* and at 590 by *Thompson,* per day.

2. *Alteration of venous blood.* It comprehends the changes which the fluids that are to be converted into blood, undergo, since they all unite with the venous blood in the sub-clavian veins.

* We do not admit with *Le Gallois,* that Hæmatosis begins from the moment that the three fluids are united.

Differences of	*Venous blood.*	*Arterial blood.*
Colour	reddish brown .	vermilion.
Odour	feeble	strong. *Moscati* made of it a peculiar element of the blood.
Temperature . .	31° *Reaumur* . .	more than 32° *Reau.*
Capacity for caloric	903° *Davy* . . .	913° *Davy.*
Specific gravity .	1052° do. . . .	1049° do.
Coagulation . .	less quick . . .	more quick.
Serum	more abundant .	less abundant.

The conversion of the blood is instantaneous, as is demonstrated by the experiments of *Goodwin*, and those still more ingenious of Bichat. This great physiologist adapted, at the same time, a cork to the windpipe and another to one of the carotids, and according as he arrested respiration or not, he immediately obtained black or vermilion blood. According to this experiment, it is evident that the conversion of the blood happens instantaneously, and depends on the arrival of the air.

Theories. Some ancient physiologists considered hæmatosis as an action simply mechanical; they supposed that it resulted from a close mixture which, according to them, occurred in the fine vessels of the lungs; but for a long time this opinion has been justly forgotten. There remain two other theories which divide modern physiologists.

A. *Vital theory.* It is founded on the following propositions; 1st, the quantity of oxygen employed in sanguification, is nearly the same whatever may be the richness of the air; 2d, approaching the moment of death, respiration consumes less oxygen; 3d, if there was a combustion in the chest, the lungs would be soon calcined; 4th, finally, the separation of the pneumo-gastric slackens, and afterwards

entirely suspends hæmatosis. Some have had recourse to the analogy of the other functions of the economy, the aim of which is the formation of a new fluid, &c.; in this theory it is admitted, that the conversion of the venous into arterial blood is simply the result of the action of the lungs, on the air, on one hand, and the fluids to be converted into blood on the other. Can we not say, observes M. *Adelon*, that the minute capillaries of the pulmonary veins seize upon, at the same, the oxygen of the air and the fluids to be converted into blood, and that they *fabricate* with both, the arterial blood.

B. *Chymical theory.* In this theory it is admitted, that carbonic acid and water, which disengage themselves in expiration, are the results of the combination of the oxygen of the air with the carbon and hydrogen of venous blood: hence the purification of the latter and its conversion into arterial blood; besides, it is supposed that the caloric which is disengaged during this combination is the source of animal heat.

Lavoisier only admitted at first the combustion of carbon; but not being able to find in the carbonic acid all the oxygen employed in respiration, he afterwards added, with M. *Laplace*, the combustion of hydrogen. From the more recent experiments of Messrs. *Davy* and *Gay-Lussac*, who have found the quantity of oxygen absorbed equal to that contained in carbonic acid, it becomes useless to admit this addition; besides, the analysis of the humour which arises from the pulmonary exhalation, has shown nearly the same elements as in *cutaneous transpiration;* it is more than probable that its origin is the same.

To this theory is objected all the considerations on which the vital theory reposes, besides some

particular experiments: 1st, the quantity of oxygen employed in respiration is always nearly the same; but this was the natural eonsequenee, sinee the fluids to be eonverted into blood are always nearly of the same eomposition.

2d. The air, on the approaeh of death, loses less oxygen; but does this depend on the lungs which refuse to act, or rather being less actively dilated, the fluids to be eombined find themselves but imperfectly in contact? is it not, in effect, to this cause that in these eases the imperfection of hæmatosis is owing?

3d. If there was a eombustion in the thorax, the lungs would soon be calcined; but first, this eombination is progressive, slow and continued; it only occurs in very small isolated quantities, since the bronchic extremities, being very minute, do not eommunicate with each other; moreover, what is there astonishing in this eombination, when we observe in our economy oxyds, salts &c.?

4th. The most formidable objection is that of the separation of the pneumo-gastric nerves; this division, which has been particularly made by M. Dupuytren, induces, according to this experimenter, the suspension of hæmatosis; the air must consequently lose less oxygen, and it is in effect what M. *Provençal* has remarked; but what ean we eonclude from these experiments? Is it not true that the conditions of combination are destroyed, and that the fluids are no longer found in the fit relation for their eombustion; is not this at least what we might eonclude from the experiments of M. *De Blainville*, who assures us that he has observed sanguification to continue after the division of the parvagum, from those of M. *Dumas* who, after this division, has ob-

tained the same result by inflating the lungs with air; finally, from those of M. *Brodie* and *Le Galeois*, who have supported life for some time, and consequently hæmatosis, in decapitated animals, by the same means.

5. At last the experiments of *Spallanzani*, *Nysten* &c., have been arrayed against it. They have seen dogs plunged into azote to disengage a little carbonic acid; but this objection falls of itself, when we recollect that the lungs are never completely empty of atmospheric air, to whatever extreme we may carry expiration; besides, the blood itself may exhale some of it; since, the researches of Messrs. *Vauquelin*, *Brande* and *Vogel* prove that the blood contains a small quantity of carbonic acid.

From all that precedes, we may conclude that sanguification does not exclusively result from the vital action of the lungs, as supposed by many modern physiologists, but from the chymical combination of the oxygen of the air, with the carbon, and perhaps with a little hydrogen of the venous blood. I do not assert, like the chymists, that the lungs are entirely inactive, their state of life is too evidently indispensable, for the accomplishment of the function; but it only acts when the elements are presented in a favourable condition for the combination. As to the pneumo-gastric nerves, can we not say that they have this combination under their influence, as under that of an electric current?

A question, which is not easy to resolve in the present state of the science, is, to know in what manner the contact of the oxygen with the venous blood happens. Some physiologists think that it combines in particular vessels, others presume that the oxygen, attracted by its own affinity, passes

through the porosities of the bronchic parietes, to the venous blood: this latter opinion is the most likely.

Before ending this beautiful function, *respiration*, it is proper to indicate which are its connections with the other functions; 1st, respiration subserves the sense of smelling by drawing into the nasal passages, or expelling out of them odours; 2d, we have already remarked that it was essential to suction, defecation and vomiting; 3rd, it is no less united to circulation: in effect, it can accelerate or slacken circulation; 4th, and finally, it has some relation with the voluntary movements, the expressive phenomena and the various emotions of the soul.

Efforts. Messrs. *Bourdon* and. *J. Cloquet* have demonstrated, that at the moment when the body is making any effort whatever, respiration is arrested by the following mechanism: at first we make a deep inspiration, then, the expiratory muscles are immediately contracted in order to effect expiration, the muscles of the glottis contract strongly of their own accord, so as to shut up this opening, and to oppose the issue of the air, so that the chest presents a firm point of support to the parts which are to make the effort.

Coughing and Sneezing. These two phenomena result from the sudden, and as it were convulsive contraction of the expiratory muscles, the glottis shuts only partially, and the air resounds in the nasal passages.

Yawning. It is composed of a deep and involuntary inspiration, and a prolonged expiration. This phenomena expresses weariness and the want of sleep, it is accompanied with a considerable opening of the jaws.

Sighing. It is also a deep inspiration, but it is slowly performed; it is moreover a phenomenon of expression, which is commonly united with a moral affection.

Laughing. It is another expressive phenomena, which consists in a series of short expirations, involuntary and commonly noisy. It results from the convulsive contraction of the diaphragm, which is sympathetically communicated to the facial muscles, hence the peculiar expression of gaiety of the face, with which all the features are expanded; its cause is moral.

Weeping. It occurs nearly by the same mechanism; the convulsion of the diaphragm is likewise communicated to the face, but it gives to it a very different expression; weeping is accompanied with a more or less abundant secretion of tears.

Panting or *anhelation.* It is nothing more than ordinary respiration, but accelerated.

Hiccup. In this phenomenon we observe the instantaneous succession of a sudden inspiration, in which the air enters with difficulty because of the spasmodic construction of the glottis, and a convulsive expiration, during which the air produces a peculiar noise.

It is useless to repeat here the properties of arterial blood. Its composition is nearly the same as that of venous blood; beside, we have already indicated what the physical and chymical changes are which in the act of sanguification convert them both.

CHAPTER IV.

OF CIRCULATION.

Circulation is a function by which the blood, starting from the heart, is carried into every part of the body, and brought back to its centre of departure. In man there are two circulations, the one comprehends the action by which the venous blood is sent into the lungs by the venous heart, and the return of this blood arterialized to the aortic heart; it is called *the small circulation*, or *the pulmonary circulation:* the other, comprehends the propelling of the arterial blood, by the aortic heart to every part of the body, and the return of this blood become venous, to the pulmonaay heart; this is the *great circulation.* The agents of this continual movement, have received as a whole (*en masse*) the name of *circulatory apparatus;* it embraces, in man, the hearts, the arteries, the capillary, pulmonary and general systems, and the veins.

ARTICLE 1.

Apparatus of Circulation.

1. *Of the Hearts.* The hearts are two hollow muscles situate in the middle part of the thorax, in contact with each other, and divided by a middle partition; each of them presents two cavities: one

situate at the base, the *auricle;* the other called the *ventricle.*

The heart with red blood, or *aortic heart,* is by its situation, rather posterior than to the left; its auricle is smaller than its ventricle; it is of an ovoidal form, smooth in its interior, with the exception of its auricular appendix, which presents two fleshy columns; we observe the four orifices of the pulmonary veins, the *auriculo-ventricular* orifice, and on the partition which separates it from the right auricle, a depression corresponding to the *foramen ovale,* a remainder of the *foramen of Botal,* which in the fœtus causes the two auricles to communicate with each other. The ventricle, nearly of a pyramidal form, presents in the interior, a great number of fleshy columnæ carneæ. From two of these fleshy fasciculi, remarkable for their size, spring a multitude of small fibres which bind the metral valves. Above, we observe the opening which communicates with the auricle, and that which communicates with the aorta; two membranous folds, situate opposite to each other, *(the mitral or bicuspid valves,)* occupy the auricular opening, one of these folds fills up the aortic passage when it is depressed.

The opening of the aorta, which is anterior, is furnished with three sigmoid valves with their three free margins looking upwards.

The *right heart,* the *pulmonary heart,* the *heart with black blood* is anterior by its position. It presents the same formation as the other. One auricle at the base; and in the interior of this auricle is found, behind and above, the opening of the vena cava superior; below, that of the vena cava inferior, that of the cardiac veins, and an appendix re-

markable for its fleshy faciculi; below the opening which communicates with the ventricle, and within, the depression which is the remains of the *foramen ovale.* The ventricle is of a triangular form, it presents many fleshy fasciculi or columnæ carneæ, from three or four of which arise the small fibrous cords which fix the *tricospid* valves. We observe above the opening which communicates with the auricle furnished with three membranous folds (*tricospid valves*), another opening, which leads to the pulmonary artery, and the entrance of which is furnished with three sigmoid valves.

These two hearts have a common organization: a serous membrane on the exterior, within a smooth membrane forming the valvular folds; this membrane is nevertheless different in each heart; within the heart with red blood, it is continuous with the internal membrane of the aorta and that of the pulmonary veins; it is weak, easily ossified, and is very little extensible. In the heart with black blood, there is continuity with the veins of the body and the pulmonary artery, stretches easily, not easy to tear, and little disposed to ossify. Between these two membranes is contained the proper tissue of the heart, formed with muscular fibres and fibrous zones. According to the researches of M. *Gerdy*, the muscular fibres are reflected on themselves, forming a kind of elbow of different dimensions, fixed by their extremities to the fibrous rings of the ventricular and arterial orifices. Nerves, arteries, veins and lymphatic vessels ramify in this tissue.

2. *Of Arteries.* The arteries are canals of a solid organization, endowed with elasticity, arising from a large trunk at the base of each ventricle, destined to transmit the blood propelled by the heart into

each of the capillary systems. On the left we have the aorta, on the right the pulmonary artery.

The aorta springs from the left ventricle, and is immediately divided into two portions, the one ascends to furnish with blood the neck, the head and the superior extremities; the other descending, is distributed to the chest, abdomen and lower extremities. The arteries are subdivided into trunks, and larger and smaller branches, &c.; but there is no necessity for this regular gradation in order to give origin to a small branch; thus we sometimes see small and even very small branches arising from a large trunk. Anatomists have carried the subdivision of arteries to a great extreme. *Haller* has reduced it to twenty, and even less, for each large arterial trunk. The arteries, thus subdivided, take sometimes a direct course, at others winding; they anastomose with each other, and these anastomoses are oftener met with in proportion as they are farther removed from the heart, and that the arteries are smaller. From this division of the arterial system results a tree, the trunk of which is implanted at the aortic ventricle, and the branches dispersed in every part of the body.

The pulmonary artery arises from the right heart, subdivides into two branches which follow the direction of the bronchiæ, dividing and subdividing in proportion as they advance into the lungs; so that the pulmonary artery represents also a tree, the trunk of which is in the right ventricle, and the branches expanded in the lungs.

Texture of the arteries. The arteries are formed of three coats: one *exterior*, cellular; one *interior*, smooth, polished, and continuous with the internal membrane of the heart; finally, a middle and *proper*

membrane of the arteries, with yellow, circular and transversal fibres.

3. *Of the Capillary Systems.* These are very minute intermediate vessels between the arteries and veins, forming by their assemblage, an inextricable net work, which constitutes the parenchyma of our organs. We distinguish two: 1, the general capillary system, in which terminates the arterial blood, and where the venous commences; 2, the pulmonary capillary system: the venous blood is sent into this system, and is here changed into arterial blood. Their arrangement is as important, as difficult to study; the general belief, at the present time, is, that the capillaries are almost imperceptible extremities of the arterial subdivisions, reflected on themselves, in order to form the beginning of the veins; at this point the anastomoses are so multiplied as to form a net work, but variable in the different parts of the body; that from the greater or smaller degree of the capillarity or minuteness of these vessels, sometimes results the passage of the red globules of the blood (*red capillaries*), at others the serous particles only, of this fluid (*white capillaries*). It is, lastly, admitted that in this system the communication between the arteries and veins occurs in the extremities of vessels bent into arches or simply transverse.

Of Veins. The veins are the vessels employed to return the blood to the heart; they spring by very minute radicles from the capillary systems. There are two kinds of them, the veins of the body, which bring back the blood from the general capillary system to the heart, and the pulmonary veins, which return the blood to the heart, converted into arterial in the lungs. The venous system presents a succession of cylinders, which diminish

in number, and augment in bulk, in proportion as they approach the heart. The veins of the body terminate by three large trunks in the right auricle; the pulmonary veins open by four trunks into the left auricle.

Texture. The veins have three coats: the *external* one is cellular; the *internal*, smooth, and is continuous with the internal membrane of the heart; the middle one, being the *proper membrane* of the veins, is of a peculiar nature; it is thicker, and more elastic in the pulmonary veins than any where else.

ARTICLE 2.

Mechanism of Circulation.

Let us suppose for a moment the blood arriving from the general capillary system in the right auricle; this latter dilates, is filled, then occurs its contraction, and the blood is compressed into the right ventricle. This latter being filled in its turn contracts, the fluid is driven into the pulmonary artery and the capillary system bearing the same name: here, from venous, it becomes arterial, then taken up again by the pulmonary veins and returned into the left auricle; and we observe the same phenomena as in the right heart; that is to say, the dilatation of the auricle, the afflux of blood into its cavity, then its contraction and the concomitant dilatation of the ventricle; which is filled, contracts, the blood is expelled into the aorta, and is carried into the general capillary system. In this system the composition of the blood changes, it becomes again venous, and is carried by the veins into the right auricle, whence we supposed it to start.

We see that the two circulatory circles make but

one, that the end of the one is the beginning of the other; let us moreover observe, that they are performed at the same time; in effect, the contraction of one auricle coincides with that of the other, and the two ventricles, the contraction of which, alternate with that of the auricles, are also contracted simultaneously. The dilatation of the ventricles is called *dyastole*, and their contraction *systole*.

Circulation has not been always so well understood; the ancients believed that there was only an oscillation of the blood in the veins; and since they found in cadavres the arteries empty, they supposed them destined for the circulation of a subtle fluid. Afterwards physicians believed in the circulation of the blood, carried from the heart into the arteries, and this discovery of Galen, so nearly allied to the real circulation, was the source of an error, for it was admitted that the blood was conveyed in the same manner from the heart into the general veins. *Harvey* in 1619—1628 published his discovery of the circulation.

If we wish to discover the power which thus propels the blood, and the direction that it follows, we shall see that the alternate dilatation and contraction of tho cavities of the heart is the principal power; the heart resembles a double pump, possessing the power of propelling the blood from the ventricles, and drawing it at the same time from the auricles by a kind of suction; besides, the blood can not follow any other course. During the dilatation of the auricle, the ventricle, which contracts at the same time, raises the valves which are at the auriculo-ventricular orifice, necessarily the auricle is filled up; the blood can not have any other issue. During the contraction of the auricle the ventricle, which is

dilated, depresses the *Bicuspid* or *tricuspid* valves; during this depression the arterial orifices are shut up by a fold of these valves; the reflux into the veins is prevented by the new afflux of blood which continually pours into them; the auriculo-ventricular is free and directed from above downwards: consequently the blood must enter into the ventricle; nevertheless, some physiologists admit that there is always a slight reflux of blood from the auricle into the veins; others think, on the contrary, that this never occurs in a normal state.

The ventricle thus filled with blood contracts, and by the effect of this contraction, the valves of the auriculo-ventricular orifice are raised; they shut up the communication between the ventricle and auricle, the blood can not therefore regurgitate into it; this reflux is also prevented by the new blood which at this moment arrives in the dilated auricle. On the other hand, the rising of the valvular folds has left the arterial orifice entirely free; consequently the blood is ejaculated by the contraction of the ventricle, into this orifice, the only course which it can take. Does there happen a slight reflux into the auricle, and even into the veins which open into it? Here also we find the same diversity of opinions.

Why does the contraction occur simultaneously in both auricles, and simultaneously also in both ventricles? Why does this contraction alternate between the auricles and ventricles? the partition, common to both auricles or ventricles, renders it impossible for one of these cavities only to contract. It is not so easy to assign a reason for the cause of the intermittent action. Moreover it is evident that this action could not occur simultaneously, for if it

did, the auricles could not have emptied their contents into the ventricles.

The contraction of the heart is similar to that of all the other muscles, with this difference, that it is involuntary. This contraction, that *Sthal* wished to assimilate to voluntary muscular contraction, that *Haller* ascribed to irritability, is owing to the action of the nerves of the heart, and these nerves must communicate with the integral nervous centres, as is proved by the experiments of *Le Gallois.*

The contraction of the heart is active, but is its dilatation passive? Is this dilatation only the mechanical result of the pressure of the blood? Nothing of this kind is observed. The dilatation is produced before the entering of the blood into its cavity. A heart torn from a living animal, contracts and dilates itself, although empty of blood.

In these different movements of the circulation, the heart experiences some sensible changes. During the systole, its tissue is hardened, it shortens, its apex strikes against the thorax, within the left cavity, between the sixth and seventh ribs. In dyastole, the contrary phenomena happens. This shock of the heart against the thorax, that several anatomists had attributed to the lengthening of the heart, evidently depends on other causes, since in this elongation, the valvular folds would be depressed. Three causes produce it: 1, a kind of tilting is produced on the base of the heart, which is fixed, and on which it moves as on a fulcrum; 2, the auricles, which are filled with blood, not being able to depress backwards the vertebral column, push the heart forward; 3, lastly, the aorta and the pulmonary artery, which receive a great impulse from the blood, transmit this impulse to the heart.

It remains for us to appreciate how far the influence of the heart on the circulation extends. *Harvey* ascribes all the circulatory action to this organ; others extend its power no farther than the beginning of the arteries; others again, to the extremities of the arterial system. We shall treat of these questions in the following article.

Circulation of the Arteries. The arterial circulation begins at the heart, and terminates in the general capillary and pulmonary systems; two causes preside over this circulation: the one, undoubtedly the most powerful, is the action of the heart; it diminishes in proportion as it approaches the extremity of the arteries, as is proved by the jerking flow of the small arteries; this jerking flow disappears in the very small arteries; the other is the arterial action, which is a power of this tissue (*elasticity*,) and another vital power, (*contractility*); elasticity predominates in the large trunks. This power of the circulation, which indeed is only secondary, is rendered obvious by experiments: for example, if two ligatures be placed on the primitive carotid of a living animal, and the intermediate part be punctured, the blood jets out, although it is no longer under the influence of the heart; elasticity is not the sole agent of this phenomenon, for in the same experiment repeated after death, the blood comes out likewise, but not in a stream, or with a jet much smaller than during life. Thus pressed by the action of these two powers, that of the heart, and that of the arteries, the blood arrives in the capillary system. It can not return into the ventricles; the sigmoid valves, and the afflux of more blood into the ventricle prevents it.

But the blood in its progress has obstacles to sur-

mount; indeed its flow is not uniform in all the arteries. These obstacles are: the mass of the blood to be moved, augmented in some places by a direction contrary to the laws of gravitation; the friction which augmenting with the divisions, the length, the anastomoses, the curvature, and the narrowing of the arteries. In a word, we must take into consideration the effort which tends te separate the arterial parietes from their axis, when the blood, expelled by the ventricle, communicates a shock to that which is already contained in the arteries. This lateral dilatation, which occurs with a throbbing, has received the name of *Pulse.* The pulse presents numerous varieties at different periods of life, and under the influence of a multitude of causes to which man is subject.

Circulation in the capillary system. The blood, brought on by the arterial extremities into the capillary system, passes into the veins without interruption of circulation; this passage occurs by *special* power inherent in the capillary system, and perhaps somewhat by the continuation of the action of the heart and arteries. This latter cause acts very feebly, if we consider particularly that many animals have no heart, that even the fœtus has been deprived of this organ, in whom the capillary circulation was nevertheless carried on; finally, what can be the effect of so feeble a cause on vessels divided and multiplied to infinity? *Bichat's* opinion on this subject was, that the whole of the movement communicated by the heart, was entirely exhausted at this point of the circle, and has ascribed the capillary circulation to the sole action of this system. Since, Doctor *Wilson Philip* has demonstrated by microscopic observations, that in fact

circulation in these vessels, is immediately controlled by their peculiar action. But in what does this action consist? Microscopic experiments, and pathological condition, seem to demonstrate in them a kind of vital aspiration or suction, which draws the blood into the parenchyma of the organs. This action, under the control of nervous influence, is, like the latter, subject to variations. There are also some physical causes which may help the capillary circulation; these causes may also become hindrances. Such are gravitation, movements, &c. The obstacles are here as in the arteries, the mass to be moved; the augmented friction by subdivisions and capillary curvatures. It is generally remarked that this circulation occurs slowly; besides, its rapidity must vary in every organ according to the degree of their activity; lastly, it must be modified in the same organ by the changes that it may experience.

It is in the general capillary system that the arterial blood becomes venous, and in the pulmonary capillary system, that the venous blood becomes arterial. In the first case some principles have probably been removed, and in the same manner it loses some of its principles by its combination with the oxygen in the second case.

Circulation of the veins. The venous circulation commences in the general capillary system, and terminates in the right auricle, and the pulmonary capillary system in the left. The causes which occasion the circulation are, the action of the capillary systems, and particularly the action of the veins, perhaps also a remainder of the impulse communicated by the heart and arteries. Dr. *Bary*, in a memoir read lately at the institute, supposes that

the venous blood is drawn into the right auricle, by the vacuum which results from its dilatation, and by the atmospheric pressure.

The movement communicated to the blood by these agents is somewhat slow; indeed nature seems to have husbanded a certain number of mechanical means in order to surmount the obstacles which hinder the circulation of the blood, and accelerate its progress. Such are the throbbing of the arteries, muscular contractions, the gradual and progressive diminution of the calibre of the vessels in which the blood flows, the existence of the small valves destined to prevent the reflux of the blood, and to divide it into small columns easier to move; lastly, the parietes of the superficial veins are considerably thicker. Moreover, the dilatability of the veins and the great capacity of the venous system are means employed against the danger of stagnation. The flow of the blood in the veins happens uniformly throughout without jerkings, its rapidity being not so great as in the arterial system, augments in proportion as it approaches the heart; the inverse of this is the case in the arterial circulation.

Portal circulation. We can not conclude this article on venous circulation, without saying a few words on the abdominal venous system. This system results from the junction of two distinct main branches united into a common trunk. One of these two branches receives all the blood of the digestive apparatus, the other ramified in the liver, distributes in it, the blood transmitted to the latter of these branches by the former. This blood, thus transmitted from the former to the latter of these branches, passes through two capillary systems, that of the digestive organs and that of the liver. We must necessarily admit that the same power which has

caused the blood to circulate in the vena partarum has led it through the liver into the sub-hepatic veins.

Such is the circulation when considered in an individual who respires; but in the fœtus it presents important modifications worthy of our attention. We shall only treat here of the peculiarities which it presents at the time of birth; referring to the history of the functions of the fœtus for the differences that it presents at the different periods of its development.

Fœtal circulation. The essential differences of the circulation of the fœtus at its birth, from that of the adult, depend upon some remarkable arrangements of the heart and vessels. 1, The ombilical vein goes, on one side from the placenta into the vena partarum, and on the other from the *ductus venosus* into the vena cava ascendens or inferior; 2, the partition of the two auricles is perforated by a hole called *foramen ovale;* 3, the right auricle near the orifice of the vena cava inferior is furnished with a valve (*Eustachi*) so disposed as to direct the blood of this vein into the foramen ovale; 4, a canal called *canalis arteriosus* uniting the aorta with the pulmonary artery; 5, lastly, the two ombilical arteries proceed from the primitive iliacs and direct their course to the placenta.

From this arrangement, it is evident that the circulation of the blood is very different from that of the adult; *Wolf* and *Sabatier* have described its progress in the following manner. Being absorbed by the ombilical vein from the placenta, the blood is partially taken into the vena portarum and in part into the vena cava inferior, where it is mingled with that which comes from the inferior extremities; hence it is poured into the right auricle of the heart, it passes immediately into the left auricle through

the foramen ovale, then into the ventricle of the same side, and is ejected into the aorta and superior extremities. On the other hand, the vena cava superior brings back, like in the adult, the blood from the superior extremities, and pours it into the right auricle, whence it goes into the right ventricle, and from this latter into the pulmonary artery; from this, it is directed in part into the lungs and in part into the aorta, through the canalis arteriosus; united in the descending aorta with that which is directly brought from the placenta, it is distributed on the one hand, in the whole inferior half of the fœtus, and on the other, it is carried back to the placenta by the ombilical arteries.

The immediate consequences of this arrangement are: 1, that the two circulatory systems communicate through the foramen ovale; 2, that the whole blood does not return to the placenta; 3, that the superior parts receive the richest blood, since it comes directly from the placenta, in which it has been revived, and that the inferior receives it only after it has passed through the superior half of the body; 4, lastly, that this circulation presents two circles crossing each other in the manner of the figure 8 in the heart itself.

Bichat and *Magendie* believe, on the contrary, that the blood of the two venæ cavæ is mingled in the right auricle, and that it immediately fills the left auricle, that these two cavities contract to force it into the ventricles, and that these latter expel in their turn an identical blood throughout the whole body.

At the time of birth, the foramen ovale, already very narrow, entirely disappears, and the circulation assumes the course which it presents in the adult.

CHAPTER V.

OF ASSIMILATION.

1. *Composition.* Now that we are acquainted with the functions which prepare the vivifying element and disperse it every where, we are necessarily arrived at that function which assimilates it with our organs, and continually renews their substance. Such is the end of assimilation.

Properly speaking, this function has no apparatus; it occurs in every part of the body, every organ is the seat of its action: it happens within their parenchyma; it is, therefore, the knowledge of this parenchyma that we need at this time; its anatomic elements are vessels and nerves ramified to infinity, and kept together by a cellular web; but what is the mode of aggregation in these parts? what is their proportion in the different organs? we know not; we do not know even how the vessels terminate; injections only prove that they communicate with each other. Among the anatomists, some are of opinion that the capillary veins are a continuation of the arteries of the same kind, they admit then lateral pores or nutritive exhalents; others presume that there exists between the capillary extremities of the vessels, an intermediate spongy tissue.

Our knowledge of the intimate structure of the organs being so obscure, it necessarily follows that

we must be equally so of the mechanism of assimilation.

In effect, this action is scarcely known but by its result. It is generally admitted, since *Le Gallois*, that the blood reaches the parenchyma of each part without experiencing the least alteration, and that it is changed into their own substance;* but we know nothing positive concerning this transformation; and, according to the different ideas which have been entertained with respect to the termination of the arteries, it is believed that the vivifying materials circulate in the nutritive exhalents, or ooze through the pores, or through the spongy tissue of the vessels. But again, is it by a simple mechanical deposition that the organic molecules appropriated to the sensibility of each part, are assimilated to the organs? or does there happen a special elaboratory action in the parenchyma? In order to admit the former of these two opinions, it would be necessary first, to demonstrate the primitive existence of the different organic tissues in the blood, and this is far from being proved; since gelatine, osmazome, the cerebral substance, phosphorus, sulphur, and some metals that analysis prove to exist in the organs, are not met with in the blood. The physiologists who advocate the latter hypothesis, suppose that these principles may very well result from the reciprocal action of the elements of the blood, or rather from the elaboratory action of the parenchyma: this may possibly occur with respect to osmazome, the cerebral substance, &c. But although it is easy to ac-

* Many ancient physiologists believed that the blood underwent different modifications, according to the organs for which it was destined.

count for these organic principles, we can not conceive how the metallic or metaloid elementary bodies should exist. Is it not more probable that these principles, which, however, exist in our aliments, should be found in the nutritive fluid, but in too small proportion to be detected in it?

Many whimsical hypotheses have been advanced about the mechanism of assimilation: for example, the physiologists who considered the cellular tissue to be the only element of every part, thought that the albumen of the blood was coagulated by heat in this primitive tissue, and that afterwards this latter assumed different forms and densities by the pressure of the neighbouring arteries: hence resulted the different organs; the chymists supposed that this coagulation occurred by the oxygen of the blood. It is scarcely worth our while to refute such hypotheses.

It is generally admitted that this movement of assimilation occurs instantaneously, like that of hœmatosis; but its activity must be materially influenced by a multitude of circumstances depending upon the healthy or morbid condition, and particularly on the nature and quantity of the aliments. There is a medical proverb, *that rich aliments make good blood, and good blood a sound organization.*

2. *Decomposition.* The *interstitial* absorption of *Hunter*, and the *organic* of *Bichat.* The continual assimilation of new molecules with our organs would soon have produced a monstrous exuberance, if the admirable foresight of nature had not added to the movement of composition, another which opposes it in its result. The correct experiments of *Duhamel, Baroni, Ludwig,* &c. prove in an incon-

testable manner that our nutrition is entrusted to the succession of these two movements; these experimenters have fed several animals exclusively on aliments coloured red with madder, and after some time all the organs, even the bones, presented one uniform colour; afterwards having ceased to feed them on coloured substances, they observed that by degrees this red colour disappeared completely: it was therefore natural to conclude, that the animal economy is composed and decomposed continually

The mechanism of this decomposition was described in the article of absorptions; we have already seen how obscure the subject was. It is probable that the venous and lymphatic absorptions simultaneously concur in it, and it is generally believed that they always take up the oldest molecules.

From the harmonious succession of these two phenomena, results that there occurs in our organs a continual molecular renovation, by virtue of which, in the course of time, the whole economy is entirely changed; the animal machine, according to the ingenious comparison of M. *Richerand*, resembles the vessel of *Theseus*, which had been so repeatedly repaired and refitted during the voyage, that when he returned home not a single part of its primitive construction remained.

Ancient physiologists have reckoned seven years to be the time necessary to produce a complete change in man; but it is probable that it varies for each individual according to the activity of nutrition, and for each organ according to the degree of its vitality; so that it is impossible to establish a general law.

CHAPTER VI.

OF CALORIFICATION.

The blood serves not only to nourish the organs, but, by penetrating into their parenchyma, it keeps up their temperature at a uniform degree, whatever may be the ambient temperature. Thus *Tillet* and *Duhamel* have witnessed a girl to bear, during ten minutes, a temperature of 112 degrees of heat without hers being modified. *Banks*, *Solanders*, *Fordyce*, *Berger*, &c., have entered a stove room heated to 79° without experiencing any inconvenience.*

M. Edwards has remarked that the temperature of the body presented some differences according to the age, sex, temperament, the healthy or morbid state, &c., he observed that it rose from 34 to 35 (*Th: cent:*) in children: from 35 to 36 in sexagenarians; from 34 to 35 in octogenarians.

Source of Caloric. The ancients placed it in the heart; *Descartes* admitted an ebullition of the blood in that organ; *Van-Helmont* an effervescence; *Vieussens* a fermentation; *Borelli* presumed that the movements of the heart disengaged an ignited spirit, &c.

At the time of the discovery of the chymical theory of respiration, the combustion of the carbonic

* The degrees here alluded to must be of Reaumur, although it is not mentioned in the original. TRANS.

gas was looked upon as the essential source of caloric. *Lavoisier* and M. *La Place*, in order to convince themselves of it, placed animals in a calorimetre, and comparing the quantity of carbonic acid gas formed, with the quantity of heat produced in a given time, they perceived that the caloric disengaged was that which necessarily supported the quantity of acid formed. *Crawfort* added that the arterial blood, having a great capacity for caloric, absorbed it in proportion as it was disengaged by combustion, and acquired consequently a degree of heat superior to that of venous blood. If, to these considerations, we add that heat is the greater, in the animal scale, as respiration is the more capacious; that animals bear worst deprivation of air in proportion as their temperature is higher; finally, that heat is diminished in the same ratio that respiration is interrupted, as was observed by *Le Gallois*, *Thillaye* and *Brodie*, we shall naturally be led to this conclusion, that respiration, properly so called, is, if not the only, at least the principal source of caloric.

M. *Chaussier* has made heat one of the primitive, vital properties. M. *Adelon* thinks that the lungs only induce calorification by absorbing the ambient caloric. Other physiologists presume that caloric is only disengaged by the arrival of the blood in the parenchyma of the organs. *Boin* supposes that it results from the unanimous action of the vital functions. In fact, digestion, racing, &c., augment the animal heat; but is it not by quickening the circulation, and consequently bringing the blood oftener in contact with the atmospheric air?

Lastly, Messrs. *Brodie* and *Chaussat*, by experiments which consist, in destroying the nervous

centres and by keeping up respiration by *insufflation*, and in which they observed heat gradually to diminish, incontestibly proving that the nervous apparatus is one of the sources of caloric; but it is not the only one, as they have asserted. The part which respiration takes in the production of animal heat, is established on incontrovertible arguments.

In conclusion, the lungs and the nervous centres, are the organs of calorification; as to the mode of propagation of caloric, it is evident, that on the one hand, the arterial blood distributes it all over the body, since it is charged with it; on the other, that which arises from the nervous system, is probably transmitted to the organs through the medium of the nerves.

Messrs. *Davy* and *Edwards* suppose that each organ has its own peculiar heat. It would be curious to know if the differences which are remarked with respect to this opinion, in the diverse parts, have any relations with the number of vessels, and the nerves which are distributed in them.

Generally speaking, parts are colder in proportion as they are further removed from the centres of calorification.

The causes which tend to modify animal heat.

1. *Artificial heat.* Man, as we have already observed, can withstand temperatures much above his own, and this for the following reasons. 1, The skin is a very bad conductor of caloric; consequently it takes up very little heat. 2, *Franklin* has pointed out the principal reason, which is the evaporation of the cutaneous and pulmonary transpiration, and that in this respect, the body may be compared

to an *alcarazas.** This assertion was afterwards verified by M. *Delaroche;* who, by placing animals in a close stove room loaded with humidity, in which, consequently, evaporation could not occur, has observed them to perish at a temparature a little higher than theirs.

At the moment of death, the temperature of the body is only 5° or 6°.

2. *Cold.* Man bears cold much better than heat, he either supplies himself or artificially, the continual loss of caloric that his body experiences. 1, His *calorifying* action augments in energy, and this is the reason why the chest of the inhabitants of the north, is generally very much developed. 2, The skin being a bad conductor of caloric, it necessarily permits but little heat to escape. 3, Clothing prevents also too great an escape of it. 4, Lastly, the loss of it is supplied by aliments and exercise.

Nevertheless, there happens a moment in which he is insufficient to supply his own caloric. The subtraction is too rapid and too considerable. Then his temparature lowers to 26°, and he ceases to exist; in this case death happens, according to M. *Chaussat*, by the exhaustion of nervous power, an opinion, which, as it may be easily perceived, is a consequence of the theory of animal heat.

* The word *alcarazas* is Spanish, and means an argillaceous unglazed vase, used in Spain, Morocco, Algiers and Egypt to cool water by placing it in the shade. TRANS.

CHAPTER VII.

OF SECRETIONS.

We understand by secretion, that function, by which certain organs called secretories, produce with the blood that arrives in them new humours, which, in the economy, are intended for very different uses.

The organization of every secretory system comprehends vessels, which bring to it materials for secretion, and a particular order of canals which discharge the secreted fluid; it is generally thought that these two systems ramified infinitely, are joined by their extremities.

We distinguish three kinds of secretory organs; the *exhalents*, the *follicules*, and the *glands*. We shall treat the secretions in the same order.

ARTICLE 1.

Of Exhalations.

The exhaling secretory organs are the simplest of our economy; they are formed into spongy membranes, their organization seems chiefly to be constituted of capillary vessels, which, at the moment when they exhale or permit a secreted fluid to transude, assume the name of exhalent or excretory vessels.

1. *Serous Exhalation.* This designation is given to a kind of albuminous halitus which occurs in the internal surface of the serous membranes: the *arachnoid, pleura, pericardium, peritoneum,* and the *tunica vaginalis;* these are cellular, thin, transparent membranes, resembling sacks without any opening, lining the parietes of the splanchnic cavities, and reflected over the organs which are contained therein. Their internal surface, every way in juxta position with itself, is continually the seat of an oozing, the product of which is, according to *Béclard,* mucus, having a gelatinous appearance similar to that which we meet with in the albumen of the blood. Internal absorption takes up again this humour in proportion as it is exhaled; formerly, this secretion was ascribed to some small glands. *Ruisch* has proved that they do not exist.

The serous exhalation which happens habitually in the spongy parts of the cellular tissue, must be placed in the first class of secretions.

The same may be said of the secretion of the *synovia;* the membranes, at the surface of which it takes place, have the same structure as the serous membranes; they also form sacks without opening, which line the articulations, the tendinous sheaths, and which are met with sometimes under the skin, passing over the apophysis. Their exhalation is viscous, transparent, of a saltish taste; their chymical composition is the following: water, albumen, fibrine, soda, muriate of soda and phosphate of lime. Formerly, the secretion of the synovia was ascribed to the *glandulæ synovia,* the assemblage of a fatty fimbriated structure, within the cavities of the joints. *Haller* thought that it was medullary fluid which transudes through the extremities of the bones;

such was also the opinion of *Desault*, when *Bichat* demonstrated the true source of the synovia.

We shall also refer to the serous exhalations, the formation of the aqueous humours, the cristalline and vitrious humour of the eye, and the perspiration which is supposed to exist in the interior of the vessels.

Cutaneous Exhalation. The skin, like the preceding membranes, contains in its structure an infinity of capillary vessels, which open on its surface under the name of exhaling vessels; from these continually escapes an albuminous vapour which is evaporated by the air, or absorbed by the *clothes*, then *transpiration* is said to be *insensible;* or this vapour being more abundant, appears in drops which run over the surface of the skin, and assumes the name of *sweat.*

This fluid is simple, it contains a great deal of water, a small quantity of acetic or lactic acid; some muriate of soda and potass, a little gelatine, phosphate of lime, and oxide of iron. Its quantity is very considerable; there results from the experiments of *Sanctorius*, that it is the most abundant of our secretions; many have been the means tried in order to determine the proportions, but the results have been very variable, which we might easily have foreseen by reflecting only on the differences of temperature, dryness, humidity, and the changes of the atmosphere; there are so many causes which may influence this cutaneous secretion, that varies, besides, according to the idiosyncrasies.

The mucous membranes, the organization of which is nearly similar to that of the skin, like the latter, are the seat of a transpiration which is particularly very evident in the aerian passages. This latter secretion, according to the experiments of

Lavoisier and *Séguin*, give out 2 pounds 15 ounces of liquid per day, whilst cutaneous transpiration furnishes less by one ounce. The product of the pulmonary transpiration is a mixture of sero-albuminous vapours and carbonic acid; some physiologists ascribe it to the combination of the hydrogen of the venous blood with the oxygen of the air.

The exhalation of the humour of *Cotugno* in the internal ear, may also be referred to this mucous transpiration.

3. *Adipose Exhalation.* The adipose tissue, confounded for a long time with the cellular, consists in small membranous vesicles, which receive their vessels through the small pedicle, by means of which, they cluster together like the berries of a bunch of grapes; the fatty exhalation takes place within their interior, it is a yellowish, coagulated matter of an insipid taste, containing, according to the researches of M. *Chevreuil*, *elaine* and *stéarine.** The exhalation of this matter is as simple as that of the preceding one. *Haller* maintained that it was already formed in the blood; M. *Chevreuil* has demonstrated lately its existence in it. Fat serves as a kind of cushion to the neighbouring parts, but besides it may be considered, as aliments stored up for future nourishment.

The central canal of the long bones, in the spongy substance of their extremities, and within the ossa crassa and ossa lata, and within the porosities of the compact substance, we meet with vesicles very much like the preceding, and which are likewise the seat of the exhalation of a fluid which as-

* Elaine and stéarine are the two approximate oily principles contained in fat. They have been lately discovered by M. Chevreuil. TRANS.

sumes the name of marrow, within the medullary canal, that of medullary and oily juice in the spongy and compact parts of the bones. The chymical composition of this matter is analogous to that of fat, it is only more fluid, which is owing probably to a greater proportion of *elaine*.

4. Finally, in the last place we class the secretion of the colouring humours of the skin, the pigmentum nigrum of the choroid, of the iris, and of the ciliary processes; in short, those albuminous humours which are met with in the glandulæ renales, the thymus gland, the thyroid, &c. their exhalation has been sufficiently explained by what we have already said.

ARTICLE 2.

Follicular Secretions.

Follicles are secretory organs still more complicated and less generally disseminated than the preceding; they are small vesicles situate within the thickness of the skin and the mucous membranes, on the surface of which they open through a narrow neck. Their organization is little known, we only know that they are excessively vascular, and that the sanguineous system communicates with the excretory canals, as is demonstrated by injections. These follicles are isolated, divided or agglomerated; according to the humour which they secrete, they are divided into subaceous and mucous glands.

1. *Sebaceous Secretion*. The cryptæ of the skin habitually secrete an oleaginous albuminous humour, which lubricates all the surface of the body and maintains its softness, and constitutes at the same time a positive loss of the economy; it is

very abundant and odorous in the meatus auditorious externus, the axilla, the genital organs, &c.

2. *Mucous Secretion.* The mechanism of this secretion is the same as that of the preceding, its product is *mucus*, its nature and particularly its quantity vary in each mucous membrane; generally it is white, viscous, insipid, not coagulable by heat, insoluble in alcohol, soluble in acids. It is to this secretion that we must refer the humour of the caruncula lachrymalis, the molar labial glands, tonsils, prostate, the glands of Cowper, &c.

ARTICLE 3.

Glandular Secretions.

The glands are the most complicated secretory organs; they are distinct from all the other parts; their organization is very complex, difficult to penetrate, and for this reason it assumes the name of *parenchyma*. In their structure we observe, 1st, arteries which bring the materials of nutrition and of secretion; 2d, excretory vessels which carry off the secreted product, veins and lymphatics; 3d, nerves; 4th, lastly, the cellular tissue which unites the capillary extremities of all those parts, which afterwards agglomerating, constitute the glands. *Ruisch* thinks that the vessels which bring the materials of secretion are immediately connected with those which carry off the secreted humour; *Malpighi* and M. *Richerand* suppose that there is between them intermediate follicles.

1. *Secretion of Tears.*

Organs. The lachrymal apparatus is composed on each side, 1st, of a small amygdaliform gland, situ-

ated within the orbit, on the external and anterior part; 2d, six or seven excretory ducts which open on the inside of the superior eyelid; 3d, of two lachrymal canals which arise from the free margin of the eyelids, near the internal angle of the eye, by two dark and prominent orifices which are called lachrymal points; 4th, of a small bag situated within the os unguis and sub-maxillary apophysis, in which the preceding ducts terminate; 5th, finally, the nasal canal joined to the lachrymal sack, and which opens into the inferior meatus of the nasal passages.

Functions. The ancients ascribed to the caruncula lachrymalis the production of tears; some believed that they were transuded through the cornea. *Haller* attributed its exhalation to the lacrhymal gland and conjunctiva. This fluid is continually poured over the ball of the eye by the small excretory ducts of the gland; it maintains the humidity and preserves the transparency of the eye, as well as facilitates its movements; it is afterwards absorbed by the lachrymal points, and conducted into the nasal passages, where it is mixed with the mucous. Its analysis gives a great deal of water, mucilage, phosphate of soda and of lime, and muriate of soda.

2. *Salivary Secretion.*

Organs. The salivary glands are three in number on each side of the mouth; 1. the *parotid*, situated behind the condyle of the jaw; its excretory canal (*the duct of Steno*,) opens into the mouth opposite the second molar tooth; 2. the *sub-maxillary*, placed under the base of the lower jaw; the *canal of Wharton*, which is its excretory duct, terminates in the mouth, near the frenum of the tongue; 3. final-

ly, the *sub-lingual*, provided with several canals which open near the preceding.

Functions. These glands habitually pour out into the mouth a viscous, insipid humour, which soon mixes with the air and becomes frothy. It contains much water, animal mucilage, lactate of soda, muriate of potass and of soda, &c.

3. *Secretion of the Pancreatic Juice.*

Organ. The pancreas is a gland very analogous to the preceding; situate transversely and before the vertebral column, and behind the stomach; it is furnished with an excretory canal which empties into the duodenum, below its superior two-thirds.

Function. The fluid secreted by this gland, flows, according to some authors, (M. Magendie,) continually into the duodenum; according to others it only flows at the time of digestion; it appears at least that at this time this juice is poured into it more abundantly. Its nature is not well understood, it is commonly compared to saliva; *Hoffman*, *Boerhaave*, and *Magendie*, consider it alkaline, others believe it acid.

4. *Secretion of Bile.*

Organ. The liver is the most voluminous of all the glands; situate in the abdomen below the diaphragm, above the stomach and the intestinal mass, it occupies the right hypochondrium, and a part of the epigastrium; its form is difficult to describe; one of its surfaces is convex and directed upwards and forwards, the other is concave and looks downwards and inwards; it is from this latter, which is very irregular, that arises the common trunk of the excre-

tory vessels; this canal is directed downwards and inwards, it soon meets with the duct of the gall bladder, with which it unites in a very acute angle in order to form the common biliary duct; this latter empties into the duodenum near the pancreatic canal.

The organization of the liver resembles that of all the other glands; but that which essentially distinguishes it from the others, is its receiving a great quantity of venous blood, which is brought to it by the vena portarum, from the digestive organs and the spleen.

Function. When the blood has reached the last radicles of the sanguineous system of the liver, it is there elaborated and converted into bile; hence this new product is slowly conveyed in the secretory vessels, by the sole action of the continual secretion and the habitual movements of the neighbouring parts; in its progress the more fluid parts of the bile are reabsorbed, consequently this humour becomes gradually thicker until it arrives in the duodenum.

Some physiologists think that it flows continually into this intestine, but after the period of digestion that it flows back through the cystic duct, into the gall bladder, where it is thickened, afterwards concreted, and evacuated at the moment of chylification. In his experiments, M. *Magendie* has indeed observed the bile to issue at all times into the duodenum; but other authors, arguing on the difficulty that a part of the bile must experience in the retrograde motion into the cystic duct, the common duct being however all the while open, maintain that this latter is always closed except when digestion is going on, and for this reason, the bile is obliged to flow

back into the gall bladder. The nature of this work obliges us to wave every discussion, we shall only mention that nothing induces us to believe the permanent contraction of the ductus communis choledochus after the period of digestion, and that the opinion first advanced, besides being more general, appears to us the nearest to the truth.*

The bile is a bitter viscous fluid, of a yellowish green, more or less dark; that which has remained in the gall bladder is always thicker and of a better consistency; it is this latter which serves as a type with respect to its chymical and physical properties; it contains a large proportion of water, a resinous matter, a colouring yellowish matter, some soda, phosphate, hydro-chlorate and sulphate of lime, phosphate of lime and oxide of iron. M. *Chevalier* has found in it some *picromel;* Messrs. *Thenard* and *Orfila* assert that there is none.

Many are the hypotheses advanced on the origin of the bile, some believe it to come from the vena portarum, others from the hepatic artery; finally, some have a sort of mixed opinion.

The reasons on which the first ground their opinion, are: 1, the mere existence of the vena portarum; 2, the nature of its blood, which contains more hydrogen and carbon, and for this reason better calculated to produce a fatty matter like the bile; 3, the vein seems to have, by its calibre, a greater relation to the abundance of the secretion, than that of the artery, which seems to exist simply for the nutrition of the organ; 4, finally, the communication of this

* Formerly some *hepato-cystic* canals were admitted, through which, according to these authors, the bile flowed into the gall bladder.

vein with the excretory ducts. The originaters of this opinion consider the spleen as a vascular ganglion destined to prepare the materials of the bile.

The physiologists who, on the contrary, think that the bile comes from the arterial blood, produced the following facts: 1, the analogy of the other secretory glands; 2, the absence of the portal system in the invertebrated animals; 3, some cases in which this vein was found to open into the vena cava; they add that this vena portarum is very much developed in the fœtus, and that nevertheless the biliary secretion is very small; that besides, the arterial blood is very well calculated to produce fatty substances, since it is the only source of adipose exhalation, &c.; but in this case what is the use of the spleen? The subject is open for the imagination to expatiate in, and a multitude of hypotheses are presented.

M. *Chaussier* asserts that it exhales a juice which assists in the formation of the lymph (*lymphose*). Messrs. *Tiedmann* and *Gmelin* think that it prepares a humour proper to animalize the chyle; others presume that it prepares the blood for the secretion of the gastric juice; *Lieutaud*, and in our days M. *Broussais*, consider it as a diverticulum of the circulation of the stomach. The latter believes also that the vena portarum has a similar use with respect to the intestinal canal.

Thus the source of the bile is yet an unsolved problem in the present state of physiology; it should seem necessary to institute experiments to solve it; for in so delicate a subject, induction only is not sufficient and can not serve as the basis of a demonstration.

Bile is a humour indispensable to chylification;

the superabundance of its secretion gives a peculiar character to the economy which constitutes a temperament.

5. *Secretion of Urine.*

Organs. The urinary apparatus is the most complex of all the secretory apparatuses; it is composed of:

1st, *Of the Kidneys.* These are two glands resembling a common bean, situate in the abdomen on each side of the vertebral column, before the last false ribs, and of the quadratus lomborum; they are surrounded on all sides by a cellular tissue loaded with a great quantity of fat; their volume is small when compared with the quantity of their secretion; but they receive a very voluminous artery, which may bring to them nearly one eighth of the blood of the aorta. Their parenchyma or web is composed of a cortical or glandular substance, which occupies the exterior surface of the kidney two or three lines thick, finally of an internal tubular substance; this latter is composed of a conoid collection of excretory capillary vessels (*the conduits of Bellini*) which terminate in the pyramid or papilla, which is itself surrounded by a calice.

2d. *Of the Ureters.* These are two excretory canals of the size of a common goose quill, which begin within the thickness of the kidneys by an oval cavity called the pelvis, and which results from the union of all the calices; this latter cavity is narrowed into a passage, *the infundibulum*, in order to form the ureter, properly so called, which terminates in the lower fundus of the bladder.

3d. *Of the Bladder.* It is a membranous muscular reservoir situated in the cavity of the pelvis,

anterior to the rectum or uterus, and which may be considered as the common enlargement of the two ureters which open into the inferior part of its lower fundus. Its excretory orifice or its neck, (*vesical triangle*) is somewhat higher than the *bas-fond* or lower fundus, of which it occupies the anterior part; it is furnished with a small tubercle called the *uvula vesicæ;* at first a little excavated, soon contracts to give rise to the canal of the urethra. The parietes of the bladder are formed within, by a mucous membrane; without, by a fleshy layer of which the longitudinal or oblique fibres, often anastomose with each other, and seem to arise from the neck; about the latter, they are transverse and more compact; they form the *sphincter* of the bladder. Finally, the peritonæum forms a third membrane, but it only lines the posterior part of the organ.

4th. *Of the Urethra.* It is the last part of the urinary apparatus, and the excretory canal of the bladder; beginning at the neck of this organ and terminating in the extremity of the penis in man; it ends in females immediately below the symphisis pubis, so that its length is very different in the sexes. It is composed of a mucous membrane, covered with a very vascular, spongy, and cellular tissue. In man we distinguish three distinct parts of this canal: the first is from 16 to 20 lines in length, traverses the prostate gland; slightly excavated at its middle part, it presents a kind of longitudinal projection which is designated by the name of *verumontanum*, and the orifices of the glands of *Cowper*, of the prostate, and of the ejaculator canals; the second portion is from 11 to 13 lines in length, it does not repose on any organ, and is consequently called the *membranous portion;* finally, the third part about six

inches long, is surrounded by an erectile tissue, and receives the name of *spongy;* it forms a part of the penis.

Function. 1st, *Secretion.* We are no better acquainted with the mechanism of the secretion of urine, than that of the preceding secretions. The kidneys are evidently the secretory organs. In order to prove this fact, *Galen* tied up several times the ureters of divers living animals, and every instance he observed the urine to accumulate above the ligature and the bladder to remain empty. It was generally admitted that the secretion was produced in the cortical substance; in fact, it is within this part that we observe an infinity of emulgent vessels to ramify; their communications are very numerous, and in such a manner that injections pass from one to the other, and even into the excretory radicles.

From this glandular substance the urine passes directly into the tubular conduits of *Bellini;* it oozes out from the summit of the pyramid into the calice, hence it is carried into the pelvis, and afterwards is transmitted by the ureter into the bladder. In this long passage that it makes, influenced by its own weight, the continuity of the secretion, the contractility of the canals, and the movements of respiration, the urine successively experiences modifications, it is in a measure clarified; it was at first when issuing from the web of the kidneys troubled and whitish, it becomes limpid, or of a light yellow, in proportion as it approaches its reservoir.

2d. *Accumulation in the Bladder.* The urine collects in the bladder and distends it gradually; and although the pressure is made on all sides, its enlargement is principally made from below upwards; the lower fundus presses on the rectum in man, or

on the vagina in woman; above, it rises over the pubis; it stretches and raises the peritoneum; it may even ascend as high as the navel, when the distention is very great.

It has often been asked how the urine could produce so considerable an effort in order to accumulate in so great a quantity. Formerly, it was believed, that it followed the law of liquids, the pressure of which is in the ratio of the height of the column multiplied by the base; but this explanation is unavailing when we know that in the ureter, the urine does not form a continuous stream; that if we consider that the uretus take a very oblique course in the parietes of the bladder, we shall readily conceive that these canals must be the more flattened and compressed, the more the reservoir is distended, and that afterwards the reflux becomes the more difficult. On the other hand the contraction of the sphincter of the neck, the angle formed by the urethra and the bladder, and the natural construction of the parietes of this canal, which are pressed from below upwards by the anterior fibres of the levator ani, are the causes which prevent the escape of the urine.

The time which the urine may remain in the bladder is variable. 1, According to its quantity and nature, 2, according to the ages and sexes, 3, finally, according to the healthy or morbid state of this excretory apparatus. The object of nature is evident as to the reason why the urine remains any time collecting in the bladder; it is to prevent the disgusting inconvenience of passing our urine at every moment.

3. *Excretion.* After having remained for some time in the bladder, the urine concentrates or thickens, its more aqueous particles are absorbed, it be-

comes in the mean time more irritating, it stimulates the bladder, and a peculiar want, very distinct in its object, is felt, ordinarily designated *the want of urinating*. It is one of those special internal sensations which are attended with pleasure or pain, accordingly as we satisfy or resist it.

In order to expel the urine, when warned by this sensation, the diaphragm and abdominal muscles, simultaneously contract, which pressure causes the bladder to act; this organ immediately contracts, its sphincter and the levator ani and accelerator urinæ relax. The urine, thus compressed on all sides, surmounts the resistance of the neck, traverses the whole urethra, and is darted at a greater distance in proportion as the contractions are more powerful; its jet is still accelerated by the synergic action of the parietes of the excretory canal and accelerator urinæ. Commonly, as soon as the urine has surmounted the obstacles, the combined muscles relax, and the bladder only contracts to propel the urine forward; finally, when we wish to squeeze out the last drops of urine, the levator ani contracts in order to raise the lower fundus of the bladder above the neck; and in order to afford an inclined plane to the liquid. After the excretion, the bladder resumes its position behind the pubis.

I have remarked that the action of the bladder is solicited by the pressure of the abdominal muscles; this is what happens commonly, but I did not pretend to say that it was independent of volition; it is obvious that we may urinate at pleasure without the least participation of the congregated muscles; paralysis of the bladder positively proves that these latter are insufficient to produce the urinary excretion.

Struck with the rapidity with which the liquids

introduced into the stomach are passed by urine, the ancients supposed that there existed ducts between the stomach and bladder: *Chirac* presumed that he had observed this reservoir to fill up with urine after a ligature in the ureter, which is very doubtful; on the other hand, *Darwin* induced one of his friends to take nitrate of potass, and he found this salt in the urine without discovering the least particle of it in the blood. *Brand* made the same observation on hydrocyanate of potass; but recently, M. *Fodera* was more successful. In repeating the experiments of Brande he discovered the salt in the urine and in the blood: thus this especial passage of the urine does not exist.

Haller thought, that the fluids before forming the urine were obliged to pass through the long rout of the lymphatics; but he explained the rapidity of the urinary excretion, in declaring that a thousand ounces of blood pass through the kidneys in the space of an hour; and by supposing that they contained only one tenth of urine, there would result a secretion of one hundred ounces, (6¼lbs.) per hour.

M. *Magendie* believes that the veins absorb the liquids, and transmit them immediately to the arteries, hence he deduces the rapidity of the urinary secretion.

Lastly, other physiologists presume that if the urine is evacuated immediately after the ingestion of drinks, the cause lies in the distention of the stomach, which presses on the abdominal viscera and bladder; but this hypothesis no way explains why the quantity of the urine is increased.

Urine, considered in itself, is a transparent liquid, the colour of which varies from a light amber to a deep orange, of a saltish and acid taste, of a peculiar

odour, which becomes pungent, ammoniacal when exposed to the air, of a specific gravity greater than that of water; it reddens a tincture of sun-flower; it contains, according to M. *Berzelius*, water, urea, sulphate of potass, and sulphate of soda, phosphate of soda and phosphate of ammonia, hydro-chlorate of soda and of ammonia, lactic acid, acetate of ammonia, an animal matter, soluble in alcohol, and another which is insoluble, an earthy phosphate with a small quantity of lime, uric acid, silex, and mucus produced by the bladder.

Three kinds of urine are distinguished: 1, The *urine* of *liquids*, is clear, transparent, almost colourless; 2, the *urine* of *chyle*, which appears in three or four hours after meals; 3, finally, the *urine* of *blood*, which is passed in the morning, is the most perfect; it is that which serves as a type for its physical and chymical properties.

The urinary secretion, together with all the excrementitious secretions, produce the depuration of the blood, and for the same reason concur in the organic decomposition; it cleanses the nutritive fluid of the materials which are no longer fit for nutrition, or those which are too foreign to our nature, in order to be assimilated; urine, the ancients used to say, is a kind of lixivium, which carries off the impurities of the animal economy.

ARTICLE 4.

Mechanism of the Secretions generally.

We have already observed the arterial or venous blood in all the secretory organs; we have also remarked that there issued from them a new product; by what mechanism has this singular conver-

sion been produced? On the one hand, it seems that the blood preserves all its properties until it reaches the capillary extremities of the sanguineous system; on the other, we observe the secreted humour even in the finest radicles of the excretory vessels. It is then at the point where these two kinds of vessels meet, that the secretion occurs; but by virtue of what law?

1. *Physical theories.* The opinion of the gradual diminution of the vessels in fit proportion to the different sanguine globules, together with the idea that all the humours exist primitively in the blood, has led to the consideration that the diverse secretions are mechanical filtrations. This was nearly the opinion entertained by *Boerhaave, Malpighi, Haller*, &c.

Hamberger presumes that all the humours are deposited in their secretory organs by virtue of their specific gravity. Other physiologists compare the secretory vessels, to a roll of cotton which, when plunged into a mixture, would only attract the fluid which it previously imbibed.

Lately, M. *Fodera* was led, in a series of experiments, to consider exhalation as a simple transudation, and absorption as an action of imbibition, and to conclude that these two phenomena are entirely dependent on the *capillarity* of the tissues. He asks if it would be possible to extend this explanation to the follicular and glandular secretions? but here he has had the good sense to stop and to remain in a philosophical doubt on this subject.

It is evident that these different physical theories of the secretions rest on the same foundation; in effect, all suppose that the humours exist primitively formed in the blood, and this proposition is not far

from being demonstrated by the following experiments; Messrs. *Dumas* and *Prévost* have found urea in the blood of animals from which they had extracted the kidneys; they have found sugar of milk, after the amputation of the mammæ; finally, have been able to produce artificial fecundations with the blood of toads which they had previously castrated. Moreover, it is well known that in Paris M. Chevreuil has demonstrated fat to exist in the blood, and that the experiments of Messrs. *Dumas* and *Prévost*, on the extirpation of the kidneys, have been repeated successfully by M. *Segalas*.

Chymical theories. Some ancient physiologists have admitted in our secretory organs a peculiar leven, by virtue of which, the blood is converted into a new fluid. M. *Berzelius* explains secretions by an electric influence. Messrs. *Prévost* and *Dumas* presume that the secreted humours are the result of a galvanic power produced by the sanguine globules; that they represent as many galvanic plates in a state of action; the observations of M. *Fodera*, who has remarked the transudations excited by a stream of electricity, favours their opinion.

Vital theory. Most modern physiologists, dissatisfied with the preceding hypotheses, have considered secretions as actions proper to the secretory organs by which the arterial blood is elaborated in a special manner, and converted into a new humour. This opinion originated with *Bordeu:* he conceived in every secretory organ a kind of digestive action: but this peculiar organic and vital elaboration, is unknown in its nature, so that we are now still further removed from the question. This is a subtle explanation, which tends to suppress all ulterior researches of which the science stands in so much need, in order to discover the true mechanism of secretions.

CHAPTER VIII.

INFLUENCE OF INNERVATION ON THE ORGANIC FUNCTIONS.

We shall treat in a special manner the functions of the nervous system, in the article of the functions of relation; but I believe it will not be amiss to enter previously, into some considerations about the peculiar influence this system exercises over the functions which we have already considered.

In effect, the nerves extend their influence on the organic functions, and this special power, very distinct from all nervous action, has received the generic designation of *innervation.* Is it not by the suspension of this influence that we observe the interruption and even the destruction of the respiratory and digestive functions whenever the pneumo-gastric nerve is divided? Is it not by the same cause that *Le Gallois* suspended the action of the heart in his interesting experiments on the spinal marrow? Is it not by the suspension of this influence that M. *Béclard* stopped some secretions by dividing the nerves of their organs? Is it not by this same suspension that Messrs. *Brodie* and *Chossat* have observed calorification to be extinguished? Is it not finally, owing to the interruption of nervous influence that Messrs. *Dupuy*, *Dupuytren* and *Breschet* have caused horses to die by extirpating the nervous ganglia of the neck?

But does innervation uniformly extend its influence on all the organic functions? or is it confined simply to some of them? Some physiologists presume that it gradually lessens in the inferior functions, and that it even disappears in absorption and assimilation; and they argue principally from the analogy of the nutrition of vegetables; but, first of all, this analogy is too far fetched; then is it very certain that the nervous system is entirely wanting in this class of organized beings? We have, on the contrary, already observed that *Haller*, *Linnæus*, and *Brachet*, considered as such, the central marrow or pith, together with its diverging rays, and that M. *Dutrochet* had discovered true nervous ganglia in several vegetables.

On the contrary, most modern physiologists think that innervation presides over all the organic functions; they only add that in the same degree as we examine the more concealed actions, its influence becomes more and more independent of the nervous centre. According to them, the nervous system is the first and main spring of our economy; this system is the causing or conducting agent of the principle of life; it pre-exists even to organization, according to Messrs. *Dumas* and *Prévost*, who have found the rudiments of it in the spermatic animalcules.

Authors do not generally agree on the nerves, the functions of which are to impart innervation. Some think that all the nerves equally concur in it; others, *Bichat*, *Reil*, Messrs. *Gall*, *Broussais*, &c. suppose, with more reason, that this important function is the attribute of the parvagum and the sympathetic nerve. On the one hand, the former is a cerebral nerve; it animates the three principal organic functions, digestion, respiration and circula-

tion, and it is from this important nerve that they derive their pre-eminence; on the other hand, the sympathetic penetrates with the blood vessels into the parenchyma of every organ; it is very distinct from all the other nerves; it has been observed to be nearly insensible to every kind of irritation: indeed this is the character of most of our organic functions to which it is specially distributed; they are performed clandestinely without our knowledge or the least consciousness. On the other hand, according to *Ackermann*, this nerve is the first developed in the fœtus; it exists in all anencephali, therefore, it immediately accomplishes the purposes of vegetable or organic life. According to *Béclard*, its ganglia are destined to arrest the influence of the nervous centres on the organs of organic functions, and to intercept the transmission of their impression; so that they divide the vegetative functions from the functions of relation; moreover, they concentrate the nervous influence that they either develop, or borrow from the spinal marrow, to distribute it afterwards to the organs which they hold under their dependence.

Thus the organic nervous influx comes, on the one hand, from the encephalon through the pneumogastric nerves, and on the other from the splanchnic ganglia, which probably draw theirs also from the spinal marrow. Of what does this nervous influx consist? is a question about which we must confess our entire ignorance; a great number of facts tend to establish its analogy with the galvanic fluid. 1st, *Wilson Philip*, has restored digestion, calorification, and secretions, by a galvanic stream, after dividing the nerves. 2d, The nervous fluid itself develops the galvanic fluid; thus *Aldini* has produced muscular contractions by causing the nerve

to communicate with the muscle through a metallic circle; M. *De Humboldt* has even remarked that it was sufficient to approach one of the poles at the distance of a line, from the muscle, to cause it to contract. 3d, When the nerves are divided so as to arrest the nervous influx, this latter continues to flow, if the two extremities are not too far from each other, and this happens, without doubt, through *influence*, as it occurs in the electric fluid. Next follow the experiments performed by *Prévost* and *Dumas* on muscular contractility, that they represent as an electric phenomenon, &c.

FIRST CLASS.

SECOND ORDER.

FUNCTIONS OF RELATION.

The functions of relation warn man of his own existence; they establish between him and the whole universe the relations best calculated for his preservation; they are four in number: the function of sensations, that of the intellectual or moral actions, that of voluntary movements, and that of expressions.

CHAPTER I.

OF SENSATIONS.

ARTICLE 1.

Of Sensations generally.

To sensations we are indebted for the knowledge of ourselves; they also positively instruct us of the existence of the bodies which surround us, they preside over our preservation, by causing us to shun dangers, and in warning us of the wants of our economy; they also invite us to live in society; sensations, finally, solicit the connexion of the sexes, and consequently, preside over the preservation or perpetuity of the species.

Sensations are induced under the influence of a certain irritation; but this irritation sometimes results from the application of external bodies, or the particles which arise from them on our surface; at others, on the contrary, they arise from an internal modification of the deep seated organs, hence necessarily the distinction between external and internal sensations.

Whatever may be this difference, however, as to the source of impression, the mechanism of the sensations is the same for all. Some physiologists, at the head of whom we find M. *Gall*, think that they are entirely produced in the organs to which we refer them; nevertheless it is more generally admitted that they require the interference of the brain; we think, also, with the greater number of authors, that the sensible parts experience only impressions which are transmitted to the brain, and that it is this organ only which decides the impression.

Relatively to the action of impression, *Haller*, *Zimmermann*, *Bordenave*, *Housset*, &c., presume that there exist in the body some insensible parts, and consequently not fit for this action: other physiologists deny this position; what is certain is, that all the parts may develop morbid sensations. But by what mechanism is the impression conveyed to the brain? Here observation stops, and by turns the circulation of the animal spirits, of the nervous fluid, of the vibration of the nerves, &c., have been conjured up; but all these hypotheses are now generally abandoned as untenable. Has the electric fluid any part in the production of this phenomenon? This conjecture assumes the semblance of a reality, if we recall to mind, that in the article of innervation we have related a multitude of facts, which establish a

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great analogy between the nervous and galvanic fluids. Finally, in what does consist the perceiving action of the brain? we must again answer, that we are, concerning it, in a profound ignorance.

ARTICLE 2.

Organs of Sensations.

The nervous system is the organ of all the sensations; it is the instrument by virtue of which man perceives impressions, and experiences sensations; it is therefore indispensable that we should have a general idea of it before treating of the sensations in particular. This apparatus is composed of the encephalon, of the spinal marrow, of the nerves, and of the sympathetic. We shall postpone the description of the brain, until we arrive at the article of the intellectual and moral functions.

1. *Of the Spinal Marrow.* It is a cylindroid chord, extended from the occipital foramen down to the last lombar vertibra. Its shape is regularly symmetrical; its thickness varies at the different points of its extent; at first enlarged at its origin, it becomes narrow, and immediately after presents a new enlargement in the cervical region; finally, it terminates on the inferior part, by an oval tubercle; before and behind it presents a median furrow, which seems to divide it from the top to the bottom into two perfectly similar portions; just under each of these fissures we meet with a layer of whitish substance, which crosses the two lateral halves according to *Soemmering*, who establishes only their continuity after *Gall.* On either side of the two median fissures, we observe collateral ridges through which issue the roots of the vertebral nerves; finally,

on the sides of the spinal marrow we meet with thirty pairs of nerves, and the ligamentum denticulatum which divides their origin. The spinal chord is formed on its exterior by a white substance, within by a grayish matter arranged into two latteral crescent-like forms united by a middle commissure. Lastly, the spinal marrow, like the brain, has a bony canal resulting from the union of twenty-four vertibræ, and three membranes, the duramater, the arachnoid, and the pia mater, or proper membrane.

2. *The Nerves* are chords formed by medullary filaments extending from the encephalon, or the spinal marrow, to the parenchyma of all the organs. They issue from the bony cavities by symmetrical pairs, then they successively subdivide from branches into filaments, which frequently communicate with each other through a simple anastomosis, plexus, or ganglia; so that the whole mass of this system presents a net work extending into every part of the body.* When the nerves have reached their last ramifications, they quit their neurilema, but we do not know in what manner they terminate. Some anatomists think that they are in a manner melted into the organs, and identify themselves with the latter; others, that they spread into membranes, as it appears in some of the senses. Finally, some

* Doctor Horner, adjunct professor of anatomy in the University of Pennsylvania, in his lectures on the nervous system, particularly inculcates that the nervous substance is every where diffused in the human body; and that even the parts in which the knife of the anatomist has not been able to trace, or discover any nerve, there exists a nervous expansion similar to a very fine gauze, or a *thin gold leaf*. Comparing in this manner, the expansion of the nervous substance, to the very great expansibility of gold. TRANS.

presume that they form papillæ in every part. Nerves are formed with filaments of medullary substance, contained in as many small cellular sheaths, and united by a general envelope called *neurilema*.

3. *The Sympathetic* is a long, nervous and ganglionic chord, extending on both sides of the spine, from the head to the pelvis, communicating by anastomosing branches with all the spinal nerves and with some cerebral nerves, and furnishing numerous filaments which accompany the arteries, and are distributed, together with the latter, in the organs of involuntary functions. This trisplanchnic nerve begins by a gangliform plexus in the carotid canal, and the cavernous sinus; from this point it sends anastomosing filaments to the sixth pair, to the vidian nerve, and to the fifth pair, by means of which it communicates with the opthalmic ganglion. On the other side it descends on the spinal column, then it consists of three cervical ganglia, twelve thoracic, five lumbar, four sacral, and sometimes a coccygian; these ganglia send to each other anastomosing filaments.

Such is the nervous system as a whole; we have not entered into any details; it was sufficient to give a general idea of it, to recall to mind its principal characters, in order to be able to study its functions. It is not in a physiological work that we can expect to find minute anatomical descriptions.

The nervous system, as we have already observed, is a continuous whole, anatomically speaking; but are its different parts independent, or have they a common centre? Secondly, are they intrusted with the same functions, or each with different functions?

1. It seems to be well demonstrated, at least in man, that the nervous system is subordinate to a cen-

tre; some place it in the brain, others in the spinal marrow; however, if we consult the most peremptory experiments, it is to the point of union of these two parts, i. e. the *medulla oblongata*, that we are induced to grant the pre-eminence.

2. As to the second proposition, the nervous system forms, it is true, one entire system, all the parts of which concur to the immense function of innervation; but we must not conclude for this reason, that each of its parts does not enjoy its own peculiar action. This is, however, an opinion which has always been advocated, even to the present period; heretofore combated by *Galen* and *Willis*, was very much shaken by *Bichat*, and overturned by M. *Gall.* This latter divides the nervous apparatus, 1st, into the *thoracic* and *abdominal* nervous system, the *sympathetic* nerve; 2d, The nervous system of the voluntary movements and tactile sensations, the *spinal marrow;* 3d, Nervous system of the senses, the *medulla oblongata;* 4th, Finally, into a system of the faculties of the mind, the *cerebrum* and *cerebellum.* Since this division many experiments have been undertaken to determine, in a more precise manner, the use of each part of the nervous apparatus. The following are, in a few words, the results of the most remarkable labours on this important subject. M. *Rodolan* thinks that the brain sends, through the cerebellum, the principle of motion to the muscles. M. *Flourens* observes, that the spinal marrow, on a level with the corpora quadrigemina, is the point in which the sensations arrive, and whence the principles of motion arise, of which the cerebellum is the regulator. M. *Magendie* presumes that it is from the highest part of the spinal marrow in the cranium that the faculty of movements springs; that the

cerebellum produces the movements backwards, and the cerebral hemispheres the forward movements; he adds, that the anterior branches of the rachidian nerves are destined to voluntary movements, and that the posterior branches preside over general sensibility. Messrs. *Foville* and *Pinel Grandchamps* fix the seat of sensibility in the cerebellum, that of voluntary movements in the central substance of the cerebral hemispheres, and that of intelligence in the cortical substance. M. *Ch: Bell* has also made some experiments on the uses of some particular nerves: he has observed that the facial nerve presides over the movements of the expression of the face, and that the maxillary or trigeminus nerve was the nerve of sensibility of this part, and had under its control the movements of mastication. M. *de Blainville*, who also professes the plurality of the nervous system, remarks, that this apparatus is the result of a series of ganglia, or central parts, each presiding over peculiar functions; he adds that all these ganglia are situated on the sides, or at the extremtiies of the common centre, which he believes to be the spinal marrow. M. *Bellingeri* has lately tried to demonstrate by experiments, that the cerebrum held under its dependence the movements of extension of the limbs, and the cerebellum those of flexion. M. *Bouillaud* presumes that the anterior part of the cerebral hemispheres presides over the spoken language or language of sounds. M. *Foville*, on the contrary, has seated this faculty in the cornu ammonis.

Such are the principal opinions of modern physiologists on the use of the different parts of the nervous system; we have been able to remark, whilst treating of them, how different their opinions are,

and even how much they contradict each other; thus in the midst of contention, the question attacked on all sides, remains as yet unsolved. Nevertheless, I can not help saying in this place that the results obtained by my ancient colleagues, Messrs. *Foville* and *Pinel Grandchamps*, are those which I have found most unobjectionable and consonant to reason in my private researches.

ARTICLE 3.

Senses of Feeling and of Touch.

All the parts of our surface are formed in such a manner as to receive the contact of exterior bodies; but one of them is particularly organized in order to instruct us of their general qualities; it is the instrument of an active feeling, or what is called *touching.*

1. *Organs of feeling or tact, and of touching.* The skin is a membrane which forms a general envelope, and which is continued into the internal organs on the margin of the natural openings; it adheres to the parts which it covers, generally, in a loose manner; however, in some parts the cellular tissue, which unites it to the deeper seated parts, possesses an extreme density; it is sometimes ligamentous; finally, in other places the skin is lined with a muscular layer which communicates motion to it. The exterior surface of this membrane is smooth: it presents, 1, wrinkles, 2, small papillary ridges, 3, the hair, 4, small openings which are the orifices of its follicles.

In the organization of the skin we meet with, when examined from within, outwards, 1, the cutis, or fibro-cellular layer, which imparts to it thickness

and solidity, in which are ramified the sanguineous and lymphatic vessels and the nerves, to reach afterwards to its surface where they form that which is by *Malpighi* called the papillary bodies, or the sanguineous *buds* of *Gautier;* then we have a second membrane, which results from the union of the nervous extremities and the vessels, and the surface of which offers a multitude of small papillary erectile projections; it is covered over by a new layer, to which *Malpighi* has given the name of mucous body; very thin over the summit of the papilli, much thicker in their intervals, they are neither vascular nor nervous; it is a kind of humid varnish which contains the pigmentum of the skin. Its existence was denied by *Bichat*, *Gordon*, *Chaussier*, &c.; other anatomists, on the contrary, consider this membrane, which is in itself very thin, composed of several layers in close contact; *Gautier*, for example, demonstrates three of them; one white, deep seated; one coloured, and a third white, superficial. 2, Finally, the epidermis is the most external layer of the skin; it is an inorganic membrane which, according to some anatomists, is the product of the coagulation of an albuminous juice; according to others, it is formed by scales lapping over each other; according to M. *de Blainville*, it is a horny matter secreted on the surface of the skin. Lastly, we also meet with, in the organization of the skin, sebaceous *follicles*, the hairs, the description of which would be out of place here.

The mucous membranes are, like the skin, the seat of tactile impressions; however, their organization is the same, but a layer of mucus, called *epichorion*, is commonly substituted for the epidermis.

The *hand* is the organ of touch, situated at the extremity of a very moveable lever, it unites in its structure, a very great sensibility to an astonishing mobility; its frame is formed by 27 bones, arranged into three flexible parts playing on each other, the carpus or wrist, the metacarpus, which forms the hollow of the hand, finally, the fingers, which are five in number, in which we distinguish several flexions. A multitude of muscles are destined to give to all those parts general or particular movements very multiplied. Finally, a very delicate skin, and closely united to the subjacent parts, covers the hand; the nervous papillæ are very much developed here, particularly at the extremity of the fingers, where they are supported by a spongy tissue that some physiologists consider to be erectile; the nails, situated behind, are destined to support the soft part of the finger.

2. *Mechanism of feeling and of touch.* The mechanism of the sense of feeling is very simple; the skin, which is its organ, is continually exposed to the contact of exterior bodies, consequently it must always produce impressions. Feeling or tact occurs without our being able to detect the least change, the least action in the organ which is its instrument; of course we do not know precisely in what it consists; every thing tends to prove that the papillæ are the seat of the impression, and that the epidermis moderates its action: Tact enables us to appreciate *weight*, *consistency*, *movement*, *extent*, and above all, the *temperature* of bodies. In effect, it is tact only which causes us to experience the sensations of *heat* and *cold;* but the judgment which we make of these two qualities of bodies is not in just proportion, as we might be led

to think, with the quantity of caloric that they yield to or take away from us, because we always compare their temperature to that of the medium in which we live, and to which our body is habituated; so that a body, for example, seems to us warm because its temperature is higher than that of the atmosphere, although, it is below ours. The mucous membranes are also the seat of tactile impression, but only at their origin; the exquisite sensibility of the lips, vagina, &c. are well known.

Touch is nothing else than active feeling, or which is exercised by a special organ, organized in such a manner as to be able to run over the surface of bodies and to adapt itself to their form. We have already remarked, that in the hand we find united all the circumstances the most advantageous for this function. In every age philosophers have admired its organization; they have even ascribed to it the superiority of man over all the other animals; *Galen* used to say, it is the *instrument* of *instruments*. As to the mechanism of touch, it is the same as that of feeling, the impression is developed in the same manner, but it is more perfect, because the contact itself is more perfect.

Candillac and *Buffon* give to the sense of touch a great pre-eminence over the others; some philosophers, because of its precision, give to it the name of geometric sense; others call it the regulator of the senses, &c.; but in reality it possesses no superiority over the others as was clearly demonstrated by M. *Destutt-Tracy*. We can not deny that it serves materially the intelligence, but this is also the case with the other senses. Touch is capable of an astonishing degree of perfection by practice;

we have known blind persons to execute with their fingers some of the nicest works.

There are two peculiar sensations that I shall mention here, connected with the history of touch, because they are mostly owing to the contact of a foreign body with the skin, or the origin of the mucous membrane; one is *itching*, the other is *tickling*. The former, it is true, may be owing to an internal cause, but more frequently it is induced by the same conditions as the tact or touch, they both require a slight contact and exercised unexpectedly.

ARTICLE 4.

Sense of Taste.

This is the sense which enables us to decide on the flavour of bodies.

1. *Flavour.* This name is given both to the impression produced by sapid bodies, and to the integrant molecules of a body which induces the sensation; it is under the latter aspect that we shall examine it here.

We are entirely ignorant to which condition the integrant molecules of bodies owe their sapidity; sometimes geometrical forms have been ascribed to them in order to account for the variety of flavours: some have said, for example, that a round form produced the sensation of sweetness, that the pungent taste was the result of an angular form &c. Now the taste of bodies is pretty generally referred to the chymical nature of their molecules.

From the extreme multiplicity of flavours, a number which varies still more, because they do not produce the same impression in all individuals, it is easy to conceive how very difficult, and next to im-

possible, a classification that should embrace their totality would be. Nevertheless, we may divide them for each individual, into *agreeable*, *disagreeable*, and *mixed*.

2. *Organs of Taste.* The tongue is its principal organ. The lips and all the other parts of the mouth, the pharynx, and even the stomach, seem susceptible of receiving a slight impression from the contact of sapid bodies; these parts have even sufficed, in some cases, to re-establish taste in individuals who had lost the organ. *Ruisch* admitted a papillary apparatus.

The tongue is a muscular body, having the form of a cone flattened from above downwards, situated in the mouth, which it almost fills up; it adheres to the inferior part of this cavity by a part of its inferior surface, and to the os hyoideus by its base, whilst the remainder of its body is perfectly free; this organ presents, in its organization, some muscles which form its body, and a membrane which covers them, and which is destined to receive the impression of sapidity.

The muscles are, 1, *Extrinsic:* the genio-glossus, the mylo-glossus, the hyo-glossus, and the stilo-glossus; they move the whole tongue. 2, *Intrinsic:* they form the tongue properly so called, and move it partially; heretofore the lingual only was known. M. *Gerdy* has discovered in it a superficial, a transversal, and a vertical lingual, some oblique lingual and a yellowish elastic tissue, which occupies the base. M. *Blandin* has found in the median line of the tongue, a thin plate of fibro-cartilaginous substance, on which the transverse muscles are fixed, and which he considers as a lingual prolongation of the os hyoideus.

The membrane which forms the envelope of the

tongue, is an extension of the skin, which is modified in a proper manner to become the seat of a special sense, *taste*, on the superior surface of this organ. The papillæ are very much developed here; it is pretty generally believed that they result from the last ramifications of the lingual nerve, surrounded by an erectile spongy tissue, and to which they owe the property of projecting out, and of entering into a kind of erection; they are distinguished according to their forms, into pyramidal, fungiform, and filiform.

3. *Mechanism of Taste.* It is the sense which most resembles touch, by the simplicity of its mechanism; it consists of the following actions: the tongue is carried on the sapid bodies, or what is more ordinary, these latter are carried over the tongue in the interior of the mouth; soon after, the juices which flow into this cavity, swell the sapid integrant molecules, and brings them in contact with the nervous papillæ; from this moment the action of the impression commences, and is transmitted to the brain through the medium of the lingual nerve. On this point, however, some controversy exists; *Boerhaave* presumes that it is through the hypoglossus that this sensation is transmitted; M. *de Blainville* observes, that it is very probable that the three nerves of the tongue equally concur to produce this result. Nevertheless, most modern physiologists think, with *Haller*, that the lingual nerve is the only one proper to develop the sensation of taste. M. *Richerand* has obviously recognized, by means of galvanism, that it produced less motion than the others.

There are certain sapid bodies which produce an

impression which are more or less lasting; it constitutes what is called *after taste.*

This sense, which is located at the entrance of the apparatus of digestion, serves more to nutrition than to intelligence; it is entirely dependent on our will, and many acquire a great degree of perfection.

ARTICLE 5.

Of the sense of Smell.

Olfaction, or the olfactory sense, is destined to give us a knowledge of odours.

1. *Odours.* This name is given to the most minute particles which exhale from odorous bodies, and which produce this sensation designated *smelling.* Before *Fourcroy* and *Bertholet,* it was believed that odours existed independently of all the substances which enter into the composition of bodies. These natural philosophers have demonstrated in a positive manner that odours are nothing else than the molecules themselves of the odorous bodies, which are dissolved and suspended in the air, after being volatilized by caloric.

Odours are diffused around the bodies from which they emanate, and decrease in strength as they are further removed from them; they do not follow any determined direction, they obey entirely the course of the atmosphere; there are some, the expansibility of which is very great, and which are carried to astonishing distances: the odour of cinnamon, for instance, which, according to *Boyle,* announces the island of Ceylon while yet twenty-five miles distant at sea. Odours, already very much multiplied, vary still more according to individuals, so that it is impossible to form a perfect classification of them; we

can only, according to the sensations which they produce, divide them into *agreeable* and *disagreeable*. *Haller* admits a third kind, which comprehends *mixed* odours.

2. *Organ of Smell.* It comprehends, 1st, a great paralellipiped cavity (called *nasalpassages*), hollowed in the thickness of the face below the forehead, and above the mouth; it is divided into two lateral and symmetrical halves by a middle partition; each of them, which has also received separately the name of nasal passages, presents a superior concave wall formed by the bones of the nose, the cribriform bone, and the body of the sphenoid; an inferior wall inclined backwards, formed by the palatine portion of the maxillary and palatine bones; an internal partition, formed by the vomer and the perpendicular plate of the ethmoid; anfractuous, external parietes, inclined inwardly and formed by the os unguis, superior maxillary, palatine, the inferior spongy bone and ethmoid; it presents from above downwards, three spongy bones, separated from each other by as many meati.

The nasal fossæ extend considerably into the neighbouring bones by secondary excavations called frontal ethmoidal, sphenoidal and maxillary sinuses. The nasal passages open posteriorly into the pharynx, anteriorly they terminate on the exterior by a prolongation in the form of a triangular pyramid, which occupies the middle of the face, and called nose.

2. The olfactory membrane is a mucous membrane; it lines the nasal passages, and is reflected in the sinuses and meati; this membrane receives a profusion of vessels and nerves; it abundantly secretes mucus, which preserves its surface in a state of humidity useful to *olfaction*. 3d, Lastly, the ol-

factory nerve; it is the special organ of the sense of smelling: it arises, according to *Gall* and *Béclard*, from the medulla oblongata; it extends hence, by passing under the anterior lobe of the brain, where it is distinctly seen to go to the cribriform plate, in the holes of which it penetrates by as many filaments, ramifying into the pituitary membrane, particularly at its superior part: they have never been traced below the middle spongy bone.

3. *Mechanism of Smelling.* It is very simple; and it will be sufficient to recall to mind that the apparatus of *olfaction* is placed in the passage traversed by the air which supports respiration, and that this air is the ordinary vehicle of odours. The following, however, is what occurs: in the act of inspiration, the nose by its direction, conveys the air, which is loaded with odorous molecules, into the superior part of the nasal passages; this latter deposites them on the papillæ of the olfactory mucous surface, and this contact instantaneously develops olfaction or smelling, which is immediately propagated along the ethmoidal nerve to the brain, which receives the impression. Most physiologists believe that the nasal mucus serves to maintain the softness and sensibility of the nervous papillæ, and to dissolve the odorous molecules, in order to blunt the impression which would otherwise be too lively. In some circumstances odours reach the nasal passages by the sole power of their expansibility, which, when disagreeable, forces us to hold our nose.

As to the use of the spongy bones and sinuses, we shall see that opinions are divided; let us recall to mind, before explaining them, that the olfactory nerve has only been traced to the middle spongy bone, that it does not penetrate into the sinuses, and

that, consequently, the superior part of the pituitary membrane only, is the seat of smelling. Many physiologists think that the turbinated bones serve to increase the olfactory surface; some ascribe the same use to the sinuses. M. *Richerand* produced no sensation by injecting odours into the maxillary sinus; this physiologist thinks that these cavities are only useful to the sense of smell by retaining for a longer time, a great quantity of odorous molecules. M. *Magendie*, with several other authors, maintains that the sinuses have no other use than that of furnishing to the nasal passages a greater quantity of mucus, &c.

This sense informs us of the existence of odours, it warns us of the quality of our aliments and of that of the air we breathe. Some philosophers attribute to it the faculty of recognising places; *Rousseau* calls it the sense of imagination, because of the action of odours in the nervous system; but, for the same reason, we might as well, in some cases call it, the sense of love.

Olfaction is subject to our will, we exercise it passively or actively; it is passive by education.

ARTICLE 6.

The sense of Sight.

This is the sense which affords us consciousness of the magnitude, shape, distance, and particularly of the colour of bodies.

1. *Light.* This is a fluid eminently subtle, unconfinable, placed between the eye and the lighted or luminous bodies which are made visible, and their existence in space made known to us. According to *Descartes*, light is an ether universally dis-

seminated, and the molecules of which are moved by the internal oscillations of bodies. According to *Newton*, on the contrary, light emanates from the sun and luminous stars. According to this hypothesis, which is pretty generally admitted, bodies are only visible because they reflect a part of the light which they receive. Some physicians wished, in our time, to refer all the phenomena of light to a vibratory movement of bodies.

Light, reflected from a body, forms diverging cones, which always move in direct lines; in the medium that it traverses there may happen three things; 1st, it reaches us directly, without meeting any obstacle in its progress; 2d, or it is reflected in part or in totality by an opaque body; in the first case it brings us the image of the reflecting body; in the second, it transmits that of the bodies whence it primitively emanated; the angle of reflection is always equal to that of incidence; 3d, finally, when light meets with transparent bodies of a different density, or of a different nature, it experiences a deviation which is called refraction. When a luminous ray passes from a rarer into a denser medium, it approaches to the perpendicular; on the contrary, it is further removed from it, when it enters from a dense into a rare medium. If the refracting body has its surfaces parallel, the rays are not disturbed from their primitive direction, the refraction that they experience in entering, is corrected by that of their emergency. If the refracting body is lenticular, the rays experience such a refraction, that they converge into a point designated *focus*. Should the convexity of the lens be very great, the rays do not unite in the same focus, so that the images are delineated within too wide a circle; this is an inconve-

nience which receives the appellation of *aberration of spherisity*, and which may be remedied by covering a part of the lens by diaphragms. If on the contrary the refracting medium is a concave surface, the refraction is such, that the rays are divergent, and that their focus is beyond the concave body at the point of immersion.

The white light, as was demonstrated by the experiments of *Newton's* prism, are composed of coloured rays; each of these rays yield differently to the refractory power; so that they always experience a dispersion which gives to the object the colour of the solar spectrum. This is an inconvenience which we remedy by *achromatism*. Such are the necessary prenotions of optics important to possess for the understanding of vision.

2. *Organs of Vision*. They are composed of the accessory parts *(tutamina oculi,)* of the *eye* and *optic nerve*. The protecting parts of the eye are the *orbits*, bony cavities, which contain the muscles of the eye and a bed of fat on which this organ softly reposes; the *eye-brows*, a kind of arched projection and covered with hair, which follow the course of the superior edge of the orbit. The *eye-lashes* are two moveable musculo-membranous veils, destined to expose the eye at pleasure to the contact of the luminous rays, or to conceal it from them; there are two, the one superior, the other inferior; they are united at their extremities; the apparent size of the eye results from their degree of opening. Their internal face is furnished with a mucous membrane, which is afterwards reflected over the anterior part of the globe of the eye, and terminates, according to M. *Ribes*, around the cornea. It is called *conjunc tiva*, because it unites the eyelids to the ball of the

eye. The free margin of the eyelids is furnished with small hairs, turned outwardly, named *eyelashes*, and of a multitude of small follicles; finally, a small secretory apparatus is appropriated to produce a soft albuminous fluid, which lubricates the surface of the eye and favours its movements; it has been described elsewhere. (*See Secretions.*)

The eye perfectly resembles in its organization an instrument of dioptricks; in effect we find in it, as in a spy-glass, 1st, an exterior envelope, which forms the frame of it, and the interior of which, coloured in black, resembles a camera obscura; 2d, refracting bodies calculated to concentrate the rays of light in determined foci; 3d, finally, a diaphragm perforated with a hole in its centre, and destined to correct the aberration of sphericity. The eye possesses all these parts, and a nervous organ also to which the luminous focus, which develops the impression, tends. The sclerotica is a fibrous membrane, which has the form of a sphere, truncated anteriorly, and perforated posteriorly with a hole, through which passes the optic nerve; it is this which forms the parietes of the instrument: it receives the insertion of the muscles of the eye.

The *choroid* is a soft, brown, vascular membrane, which lines the preceding; perforated like it behind by an opening for the passage of the optic nerve; it is equally truncated anteriorly, where it corresponds to the great circumference of the iris. It is formed by the intertwining of the ciliary arteries and veins, divided into two lamina, the most internal of which is called *Ruischian.* This membrane is impregnated with a brownish pigmentum; it is this which makes the eye a camera-obscura.

The *cornea* is a transparent membrane, convex,

grooved in the anterior circumference of the sclerotica; its anterior surface, projects considerably, and is moistened with a particular mucus; its posterior is lined by the membrane of the aqueous humour. It is the first refracting body of the eye.

Aqueous humour. It is a transparent fluid which occupies the space between the cornea and crystalline. This space is divided into two parts by the iris; they are the chambers of the eye; it is generally admitted that this humour is secreted by a proper membrane which has been described by M. *Demours.* The aqueous humour is the second refracting body, convex anteriorly and concave posteriorly.

The Crystalline is a transparent lens, somewhat less convex anteriorly than posteriorly, situated at the union of the anterior third, with the two posterior thirds of the eye, and lodged in a double fold of the membrana hyaloidea. This organ is composed of a proper membrane which secretes the crystalline humour; this latter is formed by concentric ellipsoidal layers, thicker in proportion as they are central; most anatomists consider the crystalline to be inorganic. It is the lens of the eye; its surface is bedewed by a viscous humour called by the name of *Morgagni.*

The vitreous humour is perfectly transparent, it occupies the three posterior fourths of the eye, and is circumscribed on all sides by a very thin membrane *(the hyaloid;)* it sends prolongations into the vitreous humour, and divides its own cavity into small cells which communicate with each other; it secretes the very humour which fills it up; it separates anteriorly into two laminæ which embrace the crystalline; the vitreous humour is concave anterior-

ly and convex posteriorly. It is the last refracting body of the eye.

The Iris is a circular membrane framed in the anterior circumference of the choroid; it is perpendicularly placed between the crystalline and cornea. Its centre is perforated by an opening, the dimensions of which vary according to the intensity of light *(Pupil;)* its posterior surface is coloured by a black paint; anatomists do not agree as to its nature; some suppose it muscular, others think it is vascular and nervous.* It fulfils the office of diaphragm and which corrects the aberration of sphericity of the crystalline.

Anteriorly to the frame of the iris a kind of grayish ring is found *(ciliary ligament,)* which seems to hold this membrane in its proper place. Behind the circumference of the iris we find some small triangular vasculo-membranous bodies, covered with a black pigmentum *(ciliary processes,)* from sixty to eighty in number; they are extended from the circumference of the choroid to the anterior part of the vitreous humour and the crystalline; their nature and their use are not as yet well understood. M. *De Blainville* considers them as folds of the choroid; M. *Ribes* thinks that they secrete the humours of the eye. From their erectile nature and their situation anterior to the circumference of the crystalline, might we not justly consider them as a second diaphragm?

The eye, as we have already observed, unites in its structure more than one dioptric instrument;

* This organ properly belongs to the class of membranes, called by some modern physiologists erectile tissues, and which *Bichat* overlooked in his classification. TRANS.

an organ which receives the image and transmits it to the brain, such are the retina and optic nerve; the retina is a pulpous, grayish membrane, having a slight lilac hue, situated between the choroid and the vitreous humour: it is essentially formed by the expansion of the optic nerve, and some ramifications of the central artery of *Zinn.* Within two lines of the optic nerve, on the outside of it, and in the direction of the axis of the eye, this membrane presents a yellow spot discovered by *Soemmering.* Finally, the optic nerves arise from the anterior pair of the tubercula quadrigemina, are reinforced by filaments arising from the corpus *giniculatum externum* and from the *tuber cinereum* unite over the sella turcica, expanding at last to form the retina.

Six small muscles are contained in the orbit destined to move the eye, the motions of which are well understood.

3. *Mechanism of vision.* The luminous rays which emanate from all the lighted points of a body form a cone, the base of which reposes on the cornea; this membrane, because of its polish, reflects some rays of light, which impart to it the brilliancy it possesses; the remaining part of the cone penetrates into the eye to produce an impression on its nervous organ, after having experienced different refractions. The fasciculus which occupies the centre of the cone is parallel to the axis of the eye; it falls perpendicularly over the summit of the refracting bodies, and reaches the retina without experiencing any refraction; but it is otherwise with the rays of the circumference of the cone; they take the following course; 1st, in crossing the cornea, they tend towards their axis, and consequently they augment in intensity; 2d, in entering into the aqueous humour, the

power of refraction, which is a little less than that of the cornea, are somewhat drawn from the perpendicular, so that some fall on the anterior surface of the iris which partially reflects them, producing the variegated colours of this membrane; the rays which cross the pupil are the only ones which serve for vision; 3d, these latter afterwards strike the anterior face of the crystalline; some, because of the polish of this body, are reflected and come out, or are absorbed by the blackish coat of the iris and ciliary processes; but the greater number traverse this lens, are strongly refracted, and acquire by this simple act considerable intensity; 4th, lastly, all the fasciculi thus brought together, traverse the vitreous humour, which increases the refracting effect of the crystalline, or which augments even the degree of convergency of the rays, which unite at last on the retina around their axis, in a point designated *focus*. It is this membrane which develops the sensation; the portions of light which traverse it are absorbed by the choroid. Thus in crossing the eye the luminous rays form another cone, the base of which is at the cornea, and the summit at some point or other of the retina.

The fasciculi of light which are reflected from the superior and inferior part of a visible body, cross each other in the crystalline called its *optical centre*, so that the image of the body is delineated in the bottom of the eye in a reversed situation; how does it happen then that we see it upright? *Buffon* pretends that the sense of touch has rectified this error. In effect, *Berkley* observed that the image is reversed in the bottom of the eye; but as we see our own bodies reversed, we judge of the direction of bodies when compared with ours.

How does it happen also that with two eyes we do not see objects double? *Buffon*, in order to explain the unity of sensation, has had recourse to the sense of touch; *Ackermann*, to the reunion of the optic nerves; metaphysicians have observed that it was necessary to distinguish impression from perception, which is always simple. M. *Gall* presumes that there is only one eye at any time in activity, &c.

The reach of the sight, although very different in individuals, is always limited within narrow bounds: 1st, if the object is too small, it does not reflect a sufficient number of rays to be perceived; by bringing it near the eye, the rays diverge too much, the organ has no longer any power to unite them on the retina, whatever may be the size of the bodies, so that when the body has arrived at a certain point near the eye, it ceases to see, because its refracting power is not sufficiently powerful to unite the rays which have too great a divergency; 2d, at a determinable distance, objects cease likewise to be seen, either because the rays have been absorbed in their course, or because the image becomes too small to be perceived, or finally, because the refracting power of the eye becomes too considerable, and the rays are united at a distance before the retina. The two extremes of the points of adunation of the rays of vision, so as to fall before or behind the retina, constitute *myopia* or *presbyopia*.

It is generally thought that the eye experiences internal modifications, in order to see equally at different distances; it is certain that the nearer the object is the more the pupil closes. But what is not so evidently certain is the lengthening of the eye by its oblique muscles, its shortening by its right mus-

cles, the augmentation of the curvature of the cornea, and the displacement of the crystalline, which are nevertheless pretty generally admitted.

The description, entirely physical, that we have just given of the mechanism of vision, supposes first, that the eye is perfectly achromatic; secondly, that its refracting bodies are in such relations that they adunate the luminous rays on the retina, by destroying the aberration of refrangibility.

Sight, like all the other senses, is closely connected with, and subservient to, intelligence; philosophers are divided on the importance of its attributes; some, as *Condillac* and *Berkley*, consider this sense as inferior, others considerably exaggerate its importance.

ARTICLE 7.

Sense of Hearing.

Hearing is the sense destined to make us acquainted with sounds.

1. *Sound* is that sensation which we experience when the vibrations communicated to a sonorous body strike our ear; in effect, every time that a body is struck there is produced, in its molecules, a vibratory movement, which is conveyed to the different strata of the air successively, until it reaches our ears, when it produces the sensation of sound; we can not precisely determine what are the physical qualities that render a body sonorous; we only know generally that sound is in the same ratio of its hardness and elasticity.

Tone arises from the number of vibrations which are produced in a given time; the more they are multiplied, the more the tone is acute; the appreci-

able tones are included within the limits of from 32 to 700 or 800 vibrations; the sound which departs from these extremes assumes the name of noise. Tune (*timbre*,) or the quality of sound, is generally ascribed to the nature of the sonorous body; M. *Biot* thinks that it appertains to the harmonic sounds which always accompany a fundamental sound.

The rapidity with which the sonorous undulations of the air are communicated through aerian molecules is immense; it has been reckoned at 173 fathoms in a second. Water and all the elastic solids may also communicate sound.

2. *Organ of hearing*. Situated on the sides of the head, and at the base of the cranium, it comprehends:

The external ear. It is composed of the ear properly so called, a kind of acoustic anfractuous conch, composed of the external skin, of a fibro-cartilage which gives to it its form, and of the intrinsic and extrinsic muscles; of the meatus auditorius externus ten or twelve lines long, extending from the bottom of the conch to the cavity of the tympanum, it is formed of a bony portion, of a fibro-cartilage, and of the skin which here, is furnished with follicles very much developed, which are called *ceruminous*, because of the waxy humour they secrete.

The cavity of the tympanum is an irregular cavity within the base of the petrus portion of the temporal bone; exteriorly it is divided from the external conduit by the membrana tympani; within it communicates with the internal ear, through two openings, the foramen ovale and the foramen rotundum, which are covered over by a dry, vibrating membrane, similar to that of the tympanum; below is

observed the glenoidal fissure, through which passes the anterior muscle of the malleus, and its larger apophysis; behind, several little holes are observed, which communicate with the mastoïd cells; finally, before, it presents a bony and cartilaginous canal, which opens at the superior and lateral part of the pharynx, and permits it to communicate freely with the external air *(the eustachian tube.)*

This cavity, continually filled with air, lined by a thin membrane, is crossed by a chain of four small bones articulated with each other; moved by peculiar muscles, the whole acting on the pinciple of a lever, extending from the membrana tympani to that of the foramen ovale, of which they influence the different degrees of tension. These bones are the *malleus*, the *incus*, the *orbicular*, and the *stapes.*

The internal ear or *labyrinth* comprehends three cavities, which communicate with each other: 1st, the vestibule; it is a spheroidal cavity situated between the tympanum and the meatus auditorius internus, through which the acoustic nerve passes; seven apertures are remarked in it: within, the foramen ovale; anteriorly, the orifice of the scala vestibuli, and in the remaining part of its extent the five orifices of the semi-circular canals. 2d, The cochlea, is a very bony cavity divided into two spiral canals and supported by a central cone, called modiolus; this latter is perforated by numerous little holes, through which penetrate the *cochleal* nerves; a bony and membranous partition divides the two scalæ, the external opens into the vestibule, the internal scala communicates with the foramen ovale, hence *scala vestibuli* and *scala tympani.* 3d, The semicircular canals are three in number;

two are vertical, the third is horizontal; there is between them a small triangular space which is filled with diploe, they open into the vestibulum.

All these cavities are lined with a thin membrane which exhales a still thinner transparent fluid called the humour of *Cotugno*, and which receives the ramifications of the portia mollis; this latter arises from the *restiform* body.

3. *Mechanism of hearing*. The ear so called, by its excavation, gathers the sonorous undulations and directs them towards the auricular canal; *Boerhaave* thinks that its different curvatures are geometrically disposed to produce this effect. In this first passage the sound is united into a focus; and for this reason it augments in intensity; it follows the auricular canal, and soon reaches the membrana tympani, to which it communicates its vibrations; this latter, being thin, dry, elastic as the head of a drum, and consequently well calculated to repeat the sound, transmits it to the internal ear by three several means; to wit: the chain formed by the small bones, the parietes of the cavity of the tympanum which is elastic, finally the air which fills up this cavity. Then the membranes of the foramen ovale and the foramen rotundum, and of the vestibule, which are dry and vibratory like that of the tympanum, all participate in the oscillation, and transmit it to the *lymph* of *Cotugno*. Finally, this humour, which fills up the whole labyrinth, presses the vibratory waves against the nervous extremities which float in its interior, and the impression which they receive is, lastly, transmitted by the acoustic nerve to the sensorium commune.

Sound sometimes does not follow the course which we have just indicated. For example, when

stopping our ears, we still hear the tick of a watch placed between our teeth; it is supposed then that the sonorous undulations are communicated by the bones of the cranium; in effect, this is very probable, for we know that under some circumstances solid bodies are excellent conductors of sound.

Such is, in an abridged manner, the physical history of hearing; beyond this we have no positive knowledge. But physiologists wished to give more precision and describe in a more special manner, the part that each portion of the ear acts; we shall see, while examining the principal hypotheses, that they are far from having thrown any light on this phenomenon. *Dumas* considers the membrana tympani as being formed of concentric curved lines, which have the property of vibrating each in a particular tone; others have advanced that the difference of tones results from the different degrees of tension of this membrane. The cavity of the tympanum has been considered according to some, as calculated to diminish the intensity of sounds; while according to others it increases them.

As to the small bones, it has been presumed that they strike on each other, or on the membrana tympani only; we readily conceive that such hypotheses do not deserve to be repeated. Besides the use which we have already assigned to them, it is generally admitted that they modify the degrees of tension of the membrana tympani and of the membrane of the foramen ovale.

Does the *Eustachian tube* serve only to receive the air of the cavity of the tympanum? Some physiologists maintain that it may be a passage for the sonorous undulations to enter. The same thing has been remarked with respect to the *vistibular mem-*

brane, as to the membrana tympani; at times they believed it composed of vibratory zones, at others it has been presumed that these different degrees of tensions modified the intensity of sound, or produced different tones. *Cotugno* supposed that the lymph, which fills up the labyrinth, circulated in the semicircular canals and in the cochlea, which effect was induced by the sonorous vibrations. *Lecat* considered the *cochlea* as an instrument intended to develop and produce sound. *Boerhaave* entertained nearly the same opinion with respect to the *semicircular canals;* some physiologists of his time, believed them to be filled with different liquids susceptible of vibrating in different manners.

Hearing is one of the senses which most enlarges our intelligence; some metaphysicians ascribe to it vocal language, music, &c.; without being the source of these faculties, it subserves them in a very important manner. Like all the other senses, it may acquire power and perfection by practice, and we may exercise it passively or actively, that is to say, to *hear* or to *listen.*

ARTICLE 8.

Internal Sensations.

These are internal feelings which are spontaneously developed in our organs, without the interference of external bodies. Volition has no power over them; we can neither produce nor suppress them at pleasure; the special character of these sensations is that of being all, more or less agreeable, to assume a pleasurable or painful type, accordingly as we gratify or resist the calls made by them.

All the internal sensations may be referred to three great classes.

1. Some warn us of the want of action according to the state in which our organs are found; such are the wants of *drinking, eating*, and *respiring*, as well as those of the secretions, to which we must add the want of the *connexion of the sexes*, and that of *lying-in;* finally the wants of *moving, speaking, exercising the external senses*, the *intellectual* and *affective functions*, &c.

2. The others warn us of a contrary want; it is induced when the organs have acted: to this second class we refer the want of *repose, sleep, leisure, distractions*, &c.

3. Finally, in the third class are contained the sensations which occur during the action of the organs; such are those which warn us of our movements, even those which instruct us of our existence.

Most of these sensations belong to some functions; it is to the history of the latter that we refer for their description; nevertheless, let us announce beforehand, that their mechanism is unknown, and that all our science is confined simply to observe them.

Morbid Sensations.

Pains are morbid sensations which may be produced in all the parts of our body, under the influence of the various physical or organic alterations, and which are intended to warn us of the destruction of our economy; they are infinite, language is insufficient to convey all its varieties; the ancients referred them to four species: viz., *bearing down pains, tensive, lancinating*, and *stinging* or *gnawing* pains; as to their mechanism, it is the same as that of the sensations generally.

CHAPTER II.

INTELLECTUAL AND AFFECTIVE FUNCTIONS.

There exists in the economy a peculiar order of functions, which composes the noblest attribute, and the most characteristic mark of our species, and which in reality insures its pre-eminence above all others. For a long time the exercise of these functions, the study of which constitutes *psycology*, were looked upon as the immediate and exclusive result of the operations of the soul; and some men, strangers to physiology, decorated with the title of metaphysicians, had taken possession of it: but supported by the reasons that we shall indicate hereafter, physiologists have again repossessed themselves of this beautiful attribute of their science.

These new faculties, the science of which we have already observed, constitutes *psycology*, are divided into *intellectual* and *affective;* they properly belong to moral man.

We shall begin their history by that of the encephalon; and we shall expose in a second article the analysis and use of these faculties, without passing any judgment beforehand on their organ; in a third, we shall seek to determine their material agent, for there are as yet many physiologists who are far from believing the brain to be their instrument. We shall indicate in a fourth, the sources whence this agent

draws the materials on which its operations are exercised; in a fifth article, we shall develop the modifications that different circumstances induce on this organ and on its functional operations; finally, in a sixth article, we shall treat of the various means of divination employed to judge á priori of the development of these faculties.

ARTICLE 1.

Of the Encephalon.

The description of the encephalon is closely united with the history of sensations, since, as we have already seen in the study of the latter, it is the reservoir and the perceiving organ of them; but as on the other hand it is the instrument of a series of moral acts of which we shall treat, it has appeared to us that it would be more proper to place it immediately after the sensations, heading the intellectual and affective faculties.

The encephalon is a large nervous symmetrical mass, contained within the cavity of the cranium, and is composed of three different parts: the medulla oblongata, the cerebellum, and cerebrum.

1 *The medulla oblongata.* It forms the base of the encephalon; it extends from the foramen magnum occipitis to the anterior part of the cuneiform process of the os occipitis; it presents to our consideration, 1st, at its anterior extremity, two voluminous prolongations, the *crura cerebri*, which extend into the hemispheres of the cerebrum, and by their expansion forming them; 2d, on its sides we observe two less voluminous prolongations, the *crura cerebelli*, which pass in the same manner into the lobes of the cerebellum; 3d, at its posterior extremity, it is immediately continuous with the me-

dulla spinalis, by a third prolongation called the *rachidian bulb* or *bulbus rachidicus:* this latter presents two pairs of eminences, the *corpora pyramidalia,* and the *corpora olivaria,* above two other eminences called *corpora restiformia,* which gradually separate from each other from behind forward, so as to circumscribe a triangular depression, which makes a part of the fourth ventricle, and the angle of which being very acute, receives the designation of *calamus scriptorius;* 4th, lastly, a sort of knot unites all these various parts in a central point, called *pons varolii,* the *meso-cephale* of M. *Chaussier;* its inferior surface reposes on the *basilary process,* the superior concealed by the lobes of the cerebellum and cerebrum, present from before backwards the *tubucula quadrigemina, nates* and *testes,* below which is found the *aqueduct of Sylvius;* the *valve of Vieussens;* lastly an excavated surface which, together with that of the rachidian bulb, forms the posterior parietes of the fourth ventricle.

The cerebellum. This is an irregular ovoidal organ, depressed from above downwards, and the greater diameter of which is transversal; situated in the inferior depressions of the occipital bone, above the medulla oblongata, below the posterior lobes of the cerebrum from which it is separated by the *tentorium.* Its superior surface presents a median projection, the *superior vermicular eminence* (*vermis superior*); the inferior presents a similar eminence called the *vermicular inferior eminence,* (*vermis inferior*) and a considerable depression which lodges the rachidian bulb. It is through the anterior part of its circumference that it receives its crura sent from the medulla oblongata. The whole surface of

the cerebellum presents a multitude of furrows, which divide it into as many lamelæ, somewhat regular and concentric, which are themselves subdivided into secondary lamelæ much more numerous.

The cerebellum is formed on its exterior by the grayish cortical substance, within by the white medullary substance; in the centre of this latter, we observe a grayish circular fringe called *corpus rhomboideum.*

The cerebrum. It is by far the most considerable part of the encephalon; situated before and above the preceding, it occupies the whole cavity of the cranium if we except the part comprised below the tentorium. Considered as a whole, the brain has an oval form, its surface presents a multitude of undulated eminences (*convolutions*), separated by deep fissures called *sulci;* it is composed of two symmetrical lateral halves named hemispheres, separated on their superior part by a deep longitudinal furrow (*fissura longitudinalis*); they are united on the contrary, at their middle and inferior part by the *corpus callosum.*

When examined at its inferior part, the brain presents, 1st, on the median line from before backwards, the anterior extremity of the corpus callosum, a membrane of a grayish substance, which extends from this extremity to the union of the optic nerves, the commissure of these nerves, the *tuber cinereum*, the *infemdibulum*, and the *pituitary gland*, *eminentiæ* mammillares, a transversal fissure described by *Bichat*, and through which the pia mater and the arachnoid penetrate into the ventricles; finally, the posterior extremity of the corpus callosum. 2d, On the sides of the inferior surface of each hemisphere we

remark *three lobes*, one *anterior*, bearing on the orbital vault or anterior fossa; a *middle* one, separated from the preceding by the fissure of *Sylvius;* and the last, *posterior*, supported by the tentorium.

The internal organization of the brain presents a great many remarkable parts which we shall simply enumerate. 1st. On the median line we remark the *corpus callosum;* the *septum lucidum*, in the interior of which we find the fifth ventricle; the *fornix*, below which we find the *plexus choroides*, which covers its inferior surface in the form of a lyre; finally, below again we meet with the *middle ventricle*, which presents behind, the *pineal gland*, the *posterior commissure* and the *anus*, which is the orifice anterior to the aqueduct of Sylvius. Anteriorly, the *anterior commissure*, the *vulva*, and the two holes which communicate with the lateral ventricles.

2d. On each side within each hemisphere, we meet with two large cavities, (the *lateral ventricles*,) which present to our consideration the *corpora striata*, the *thalami optici*, the *tænia striata* which separate them, the *plexus choroides*, the *posterior angles of the fornix*, the *cornu ammonis;* finally, the *digital cavity*, in which we remark the *Hippocampus Minor* or *Ergot.*

The cerebrum, like the cerebellum, is composed on its exterior of a grayish or cortical substance, and of a white medullary substance in the centre; but it contains, moreover, ganglia of grayish matter, in which its elementary fibres acquire additional fibres before expanding.

From this short description of the encephalon, we may have been able to remark that the medulla oblongata, such as we have considered it, forms a

kind of tripod, or central focus, of the nervous apparatus; on the one hand it communicates with the cerebrum and cerebellum which seem to result from its expansion; on the other it establishes their communication with the rest of the system, by being continued inferiorly, with the medulla spinalis. On a level with the foramen magnum occipitis the anterior pyramids interchange fibres; some authors pretend that this exchange of medullary substance in this place, is general.

We have considered the brain as a whole nervous mass, but M. *Gall* maintains that it results from several groups of special nervous systems appropriated to the various moral acts; most modern physiologists acknowledge his doctrine.

The encephalon presents in its volume some differences according to individuals, sexes, &c. Authors have thought they remarked, for instance, that the development and number of convolutions were in a direct ratio to the extent of intelligence; and that females had, comparatively speaking, a smaller cerebrum, and the cerebellum larger than men, &c.

The scalp, the bones of the cranium, the dura mater, the arachnoid and pia mater, are the envelopes which protect the encephalon; it receives four voluminous arteries; the two internal carotids, and the two vertebral arteries; they are ramified ad infinitum in the pia mater, before entering into its mass; its venous blood goes into sinuses which belong to the dura mater, and which pour it afterwards into the internal jugular veins.

ARTICLE 4.

SECTION 1. *Of the intellectual Faculties.*

Intellect, intelligence, understanding, mind, such are the various generic names applied to the facul-

ties by which man knows and reasons of natural agents, and turns them to his advantage, when necessity requires it, either for his utility or pleasure. We name metaphysics, and more particularly idiology the science which has for its object their study. Philosophers differ in opinion as to the number and designation of the first intellectual faculties; they are first divided into two great classes; some, *Locke* and his school, admit one single principal faculty whence the others are derived; the others, *Malebranche*, *Hobbes*, *Willis*, *Haller*, *Ch. Bonnet*, and *Gall*, acknowledge the plurality of faculties, and consequently the different use of the various parts of their organ, of the brain, although we speak of this organ in anticipation.

The first do not agree, neither on the primitive essential faculty, nor on the number of those derived from it. *Locke* and *Condillac* place it in sensation, M. de la *Romiguière*, in attention, M. *Destutt-Tracy*, in perception. From sensation, *Condillac* infers attention, comparison, judgment, reflection, imagination, reasoning. From attention M. *de la Romiguière* deduces comparison and reasoning. From perception *Destutt-Tracy* supposes memory, judgment, and volition to be derived.

Ch. *Bonnet*, *Kant* and *Gall*, have laboured to refer to original faculties, or rather, to functional results, the phenomena of mind. *Kant* admits twenty-five forms or primitive fundamental qualities, M. *Gall* twenty-seven, to which M. *Spurzheim* has added eight new faculties. Let us observe that among them we find comprised the affective or moral faculties, properly so called, of which we shall treat hereafter.

It is very difficult to fix precisely the number of

these fundamental faculties; some may be only the modifications of some others; but the plurality of the faculties seems, however, admissible on the following considerations.

By sensation, attention, and perception, (the first considered by *Condillac*, the second by M. de la *Romiguière*, the third by M. *Destutt-Tracy* as generic faculties and parent of all the others,) we may explain, it is true, the intellectual operations; but must we conclude from that, that there is no special independent faculties connected with distinct apparatus, concurring in the production of a general faculty? We see the faculties of digestion and of sensations serve to explain the digestive and sensorial phenomena, and these general functions to be, however, composed of special functions; the one of mastication, of insalivation, of deglutition, &c.; the other of sight, hearing, &c.

Why, in the series of animals, in the different ages, do we see the number or intensity of the faculties to increase or diminish, and these changes to coincide with variations in the number and form of the parts? Why so great a diversity in the arrangement and cerebral structure, if there exists one intellectual power only? If this faculty is a whole or *unit*, why do not all the persons who apply themselves closely and with attention to the study of mathematics, poetry, painting, music, medicine, mechanics, become *Newtons*, *Homers*, *Raphaels*, *Lullis*, *Hippocrates*, *Vaucansons*?

Why are there men who are ingenious with respect to one faculty, while they are mere idiots in another? Why do we see one faculty disappear and the other remain the same?

There is every probability, that the phenomena of

intelligence ought not to be ascribed to one single primitive faculty. I say likely, because this doctrine of the plurality of the primordial faculties does not remove all the objections; for instance, when we reflect on the *unity of sensation*, of *existence*, of the *self* (*moi;*) there ought to be, remarks M. *Georget*, consciousness of self as often as there are intellectual or affective faculties. Some one has answered for M. *Gall*, for I am not aware that he has ever touched the question, that there was a faculty for this perception of the thinking being, from which faculty the others were derived; but in this case, the latter would be nothing more than dispositions or tendencies.

We wonder also in seeing these faculties reciprocally borrow knowledge, to communicate with each other for the production of intellectual acts and for the accomplishment of which the simultaneous action of several of them is often necessary, and in the mean time to remain in relation with the sensorial power; but these difficulties are less striking than the preceding; and if we recall to mind that all the nerves emanate from the spinal marrow and medulla oblongata, the fibres of which diverge and form the encephalon, we shall then have obtained a part of their solution, at least of that of the latter.

In the twenty-seven primitive faculties of M. *Gall*, we shall not be astonished at not finding sensation, attention, perception, comparison, judgment, and reasoning. These are general attributes, modes of manifestation common to all the faculties of the intellect, to all the moral and instinctive qualities. A man, for example, may have, respecting mechanics, a perception, a judgment, and a ready and correct reasoning, who may have

nothing of these faculties with respect to comparative sagacity, &c. therefore we shall arrive more or less easily at the knowledge of an object according to the development of the faculties with which we contemplate it.

Perception, which is the most indispensable condition for intellectual labour, supposes sensation and attention; it procures the notion, the knowledge, the idea of bodies, but it can only give simple individual ideas. When the same perception is repeated on the particular qualities of bodies, singly or collectively, then the comparative faculty points out the reiterated perceptions, and creates the concrete, generic, and collective ideas. These ideas are abstract, because they do not possess any material type. Comparison may be exercised as well on these latter as on the former. From these concrete ideas, parent of the sciences, we draw ideas applicable to a special object. The former operation is named *synthesis*, the latter *analysis*. From comparison necessarily results judgment. Lastly, we reason when we combine the relations established between the judgments of various comparisons.

According to *Condillac*, imagination is the faculty which recalls preconceived ideas; he also refers to it memory. According to M. *Destutt-Tracy*, it is the sagaciousness in seizing the many relations, not only in painting and in music, but generally in all the arts and sciences. Memory is the faculty which recalls the idea of objects; it is active if volition sets it to work; it is passive if it alone is exercised, and the recalling of the idea is made, in a manner, without our knowledge. Then it assumes more particularly the name of *remembrance*.

Volition is a faculty, a special attribute of the *self*,

(*moi*) which irresistibly allures us towards a particular object, after a comparison has been established. Volition gratified, is followed by pleasure; if thwarted, by pain. There is often a tendency to satisfy a want, the activity of a faculty; then, accordingly as this want is more imperious, or is kept in check by another, the volition of satisfying it is more or less free. Therefore, this power of yielding to, or reristing volition, is not absolute; we possess it in a much higher degree, as we less permit one or several faculties to predominate. In a word, although moral independence, and free will, has been granted to us, its exercise is more or less easy, according to the intensity of desires.

The view which we have just given of the number and tendency of the faculties of the mind, demonstrates the difficulty of this analysis. We have seen some refer every thing to a first and single faculty, and then dispute between each other as to the one to be fixed upon, on the order of precedency and causation of those which are derived from it; others refer the intellect to several primitive faculties. The diversity of opinions will be not less, with respect to the sources whence these beautiful faculties are derived.

These new senses are more precious or useful than the ordinary senses; these latter enlarge the sphere of the existence of man but moderately; the former cause him to build cities, direct him over the seas, enable him to have intercourse with all men scattered over our planet; by them he soars into the abyss of the heavens, unfolds the movement and harmony of worlds; by them also he creates the useful arts; he animates the canvas and the marble; paints with the brilliant colours of poetry the

high deeds of heroes, the sweet and peaceable life of rustic man; finally, it is the intellect which creates and directs the expression of the physiognomy, gestures, voice, a mean of communication established between cotemporaries; moreover, by giving body to ideas, by signs or writing, he may communicate with ages to come; with this written language man prevents his own ideas from vanishing as soon as formed, and thus transmitting them to his species, insures the continual and almost infinite progress of the arts and sciences, in as much as it is in our power to improve them.

SECTION 2. *Of Affective Faculties.*

Morals are that part of psycology which treats of the affective faculties, the qualities of the heart to speak the language of worldly people, and places limits where volition must confine their use in order not to overstep the boundary of wisdom, which is a source of our happiness.

We have already seen that idiologists wish to attribute the intellectual faculties, some to an essential faculty primitive and single; others to a greater or smaller number of independent faculties. The same diversity exists among moralists.

The celebrated *Volney*, with many others, ascribes them all to self love; and as a type of the secondary classifications, he selects love or pleasure, attachment or hatred, pain or aversion. With respect to their consequences to society, we divide them into virtuous, vicious or mixed.

M. *Pinel*, considered them with respect to their effects, and classed them into expansive and oppressive.

M. *Esquirol* divides them into primitives, which belong to the animal life of man, isolated, as courage, love, hatred; and into fortitious or social, as vanity, pride, and ambition.

Lastly, M. *Alibert* causes them to be derived from four primordial laws; viz. instinct of preservation, instinct of imitation, instinct of relation, and instinct of reproduction.

M. *Gall*, we have already remarked in the preceding article, admits twenty seven primordial faculties, among which we remark the first affective faculties, desires, sentiments or passions; these are, love, attachment, self defence, carnivorous instinct, the love of property, pride, ambition and vanity. He reserves the names of affections for the various modes of being of the faculties according to the circumstances of the moment, as joy, chagrin, anger, fear and fright.

If an effective faculty is sufficiently developed or excited to constrain volition to satisfy it, to produce a lively desire, anxiety and suffering follow, hence the word *passion*.

Passions are internal and cerebral sensations, inclinations, wants somewhat similar to hunger and thirst. It is as agreeable to the *self* to gratify it as it is painful to resist it; but unrestrained conduct often leads to fatal consequences to individuals and to society; on the contrary, restraint, by sparing us repentance, prepares peace and happiness. Now, comparative sagacity, notions of just and unjust, consciousness and moral liberty, having been given to man; he thus becomes the only instrument of his own happiness or misfortune; at least in the eyes of the wise who consider man in himself, and not slave to the prejudices of the world.

All the passions are useful in themselves; provided however they are regulated, moderated by wise volition, there exist therefore no passions exclusively virtuous or vicious; all are mixed.

Passions, like intellectual operations, become for man a source of joy and pleasures if he does not abuse them. The love of progeny, friendship, erotic attachment, are elements of happiness.

By the faculty of friendship, man is allured to live in society; a precious tendency, without which he would inevitably perish in his long childhood, when we consider the imperfection of his senses, the privation of offensive and defensive arms. He has need of being fed by his parents, and that they should unfold in him that intelligence, which will hereafter transform him into a man, into a lord of the creation, being while a child, helpless and miserable.

There exist affective faculties called human, because they have been only granted to man. Such are goodness and religious instinct or theology; the former is the source of piety and generosity; it prompts men to help each other, and consequently becomes greatly useful to the formation and support of society; the latter prompts us to *love* and *adore* God, and furnishes, let it be said, one of the strongest proofs of his *existence;* for what would an *instinct*, an *inclination* avail without an *object?*

ARTICLE 3.

Of the organ of the moral Functions.

We have just passed in review the class of intellectual and affective phenomena; they have been examined independently of their agent and organ; we

must therefore fix our attention for a little while on the nature of this agent.

Metaphysicians make these phenomena proceed immediately from the soul itself; they consider them as being independent of all material instruments. Hence the names of *metaphysics* and *psycology*.

Let psycological acts be the immediate result either of a physical agent, or of an organ, or of an immaterial principle connected with this organ, we can not deny their dependence upon the material instrument; from this moment they appertain to the class of the other functions, and therefore belong to the empire of physiology.

Without wishing to decide the first question, let us try to prove that the moral faculties are influenced by the physical organization, and that the latter predominates over the former.

The intense exercise of the intellectual and affective faculties is accompanied with phenomena, and sometimes even with morbid phenomena in the head and viscera.

The alternate state of activity and repose, of excitation and of languor of these faculties, proves that this exercise is subject to the modifications of an organized matter.

Climates, diet, and pharmaceutical treatment, professions, age, sex, state of sickness, have an incontestible influence over the several functions. We have at every moment evident proofs of it; and to restrict ourselves to one fact, who does not know the results of the introduction of wine, coffee, or poison into the stomach?

If these functions were distinct from a material organ, we should consequently be forced to admit that their principle varies for each individual, either

man or animal, that each possesses a distinct soul of its own.

The material nature of the instrument of these functions, either proximate or distant, seems to be incontestible; should we not admit it, they would no longer appertain to the class of the physiological functions.

Physiologists are far from agreeing which is the material organ or organs of this function.

I am not aware, at least, that any one of them has located the intellectual faculties elsewhere than in the brain. It is far from being so with respect to the affective faculties. *Plato* used to ascribe them to the viscera; *Bordue, Buffon, Cabanis,* &c., also placed them out of the brain, and in the thoracic and abdominal viscera; *Bichat* located them in the organic or ganglionic nerves; his opinion is grounded principally on the manifestation of the effects of passions and affections towards the viscera; inasmuch as both gestures and language refer to them the sensations of these functions. But do we perceive the affective faculties to be in a just proportion with the development and excitement of these viscera? *Georget** thinks that this is not the case with the ruminating animals who are possessed of four stomachs, a voluminous liver, with an enormous heart and lungs. Do we see any change in these faculties with those persons who have any affection of the heart or liver? Moreover, these phenomena often manifest their effects towards different viscera, according to the temperament of different persons, and sometimes throughout the whole economy; thus, for instance, in fright, there may exist at the same time, a

* Georget's physiology of the nervous system.

cerebral disturbance, palpitation of the heart, and icterus; in these cases the hair has been observed suddenly to turn white, and the skin black; M. *Rostan* records two cases of this kind. Lastly, the intellectual phenomena, resting in the brain, may also produce similar disturbances in the viscera; *Tissot* adduces numerous examples of them in his treatise on men of letters.

We can not too much exert ourselves in combating this doctrine, which has been already shaken; for in admitting with *Bichat* the irresistibility of the movements of the passions, an irresistibility which he compares with that of convulsion, produced by the wounding of the brain by a splinter of bone, we are led to deny the existence of free will, and to judge that passions are not susceptible of being diminished or curbed by education.

The affective faculties, as well as the intellectual, have their seat therefore in the encephalon. It is their first cause. Is the action of the whole encephalon necessary for the exercise of the psycological functions? Is one of its parts sufficient? or have these faculties, each in particular, a part specially appertaining to their production? These are three of the most difficult propositions that the science of psycology can present.

The first proposition is untenable. It is very certain that distinct portions of the encephalon preside over the sensations and over the voluntary movements, and which are functions of a different order.

The second has also been advanced. It is notoriously known that *Descartes* located the soul in the pineal gland; others have assigned the corpus callosum as its organ, &c.

The third has been long maintained. First, most

psycologists, in admitting in psycology two orders of fundamental operations, *understanding* and *volition, intelligence* and *sensation,* &c. implicitly acknowledged the plurality of organs; for it is evident that these different functions required diverse organs. The Arabs, says M. *Adelon,* placed *common sense* in the first ventricle, *imagination* in the second, *judgment* in the third, *memory* in the fourth. Accordingly, as early as the thirteenth century, a Bishop of Ratisbon, *Albert le Grand,* published that the psycological faculties resided in the different ventricles. *Willis* distinctly announced that perception and reflection were seated in the corpora striata; memory and imagination in the centrum ovale of Vieussens, and the source of movements in the cerebellum. Since, *Bonnet, Cuvier,* and *Sœmmering,* have rather inclined towards the plurality of organs.

M. *Gall* has particularly insisted on this plurality of organs; it was an immediate consequence of the plurality of the primitive faculties. The facts and reasonings which support this first point of his doctrine, and that we have already indicated, make in favour, *à priori,* of the admission of the plurality of organs. His proofs are drawn from the following facts:

1st. The comparison of the understanding with digestion, or sensation in general; (see page 170:)

2d. The coincidence of the development of a particular faculty with that of a particular part of the encephalon, in the series of animals, and in their different ages;

3d. The frequent predominance of one faculty over the others;

4th. The decided preference that men give to this favourite faculty;

5th. Of their aptitude in its exercise;

6th. The power which enables us to suspend fatigue, and even indeed to make it a recreation, by passing from the exercise of one faculty to that of another;

7th. Monomania, idiotism or partial alienation;

8th. The lesion of a point of the brain being constantly followed by the modification of the same faculty, &c.*

But it has been objected that we often see effusions of blood, and local, circumscribed softening, (*ramollissement*) without the lesion of one organ in particular; but on the contrary we oberve a general intellectual disturbance. If we recall to mind (M. *Georget* will answer,) that the different parts of the brain are contained, and circumscribed in a cavity which does not permit any displacement, it is easy to conceive that sympathy and pressure will necessarily produce in these cases a general lesion of the brain. Those who ask how it comes to pass that the brain, composed of a substance analogous in all its parts, should, however, execute diverse functions, we shall cite the nerves of the senses and those of movements, which, although having apparently an analogous structure, have, nevertheless, different uses or functions.

Although the plurality of organs is still a subject of contention, it is, however, better demonstrated than their designation, as an agent of any particular faculty.

* See the numerous facts relating to this subject, in the work of M. Gall.

The experiments of M. *Flourens*, on the encephalon of animals, have only proved that we ought to seek these organs in the cerebrum and cerebellum; indeed this is precisely where M. *Gall* places them. By the citation of facts sufficiently well observed, but as yet not numerous, the latter author thinks himself justified in assigning the occepital region to the affective faculties, and the frontal to the intellectual. We shall see, while studying the different methods of divination of the moral faculties, that he has gone still further.

Recently, my colleagues, Messrs. *Pinel Grandchamps* and *Foville*, resident students de la Salpitrière, have advanced that the cortical substance was exclusively the part which produces the moral faculties; and to the medullary part they ascribe the movements. This proposition, although already supported by some facts, demands, however, for its demonstration, numerous and attentive researches.

ARTICLE 4.

Of the Sources and Mechanism of the Cerebral Functions.

Ideas and the knowledge of exterior objects are transmitted to the brain by the apparatus of the senses, without which the brain can not fully exercise its intellectual operations. This proposition was proclaimed by *Aristotle*, in that so celebrated axiom: *nihil est in intellectu quin priùs fuerit in sensu. Plato*, on the contrary, supposes the ideas of the nature of bodies to be innate. According to him, bodies have their essence, their model, their image, already preconceived in the mind. These images may exist therein without its being conscious of

their existence; if they are perceived by the mind, it is only by a kind of reminiscence, induced by the sensations that these bodies produced on it. *Plato* considers these types as being almost independent of the intellect. *Descartes* goes further; he presumes that they are the identical ideas of our intellect.

From the doctrine of *Plato* follows that of the *idealists*, according to whom the senses only perceive objects similar to the preconceived image. That of *Pyrrho* is also a consequence of it. *Pyrrho*, considering the senses as being deceptive, looked upon every thing as illusory, and he went so far as to doubt of motion, and even of his own existence. It is undoubtedly true, that we are only acquainted with bodies by the sensations produced within us, and compared to ourselves; we are ignorant of the essence of their matter. It may be easily conceived that animals, having the senses and a brain differently organized from ours, must have a different idea of exterior objects, and this may even happen to a certain extent with man; there is no doubt also that the senses are the agents of the intellect, and we can not help believing in their relations, when individual and general experience has confirmed them.

The Aristotilian doctrine has since been maintained and defended, by *Bacon*, *Locke* and *Condillac*. They compared man just born to a blank tablet, on which nothing was impressed but what the sensations were able to seize. There are, nevertheless, numerous notions which seem not to reach the mind through the external senses.

Are the numerous modifications of the mind produced by age, sex, hygeanic agents, &c. the necessary consequences of the harmonic modification of

the senses? Is it through the senses that the child recognises the nipple and sucks it; that the kid chooses the *cytisus* in a bundle of various plants? Is it by them that we shall be able to explain the origin of the new desires experienced at the age of puberty, the changeableness and caprices of the moral faculties at the period of menstruation and of pregnancy?

Cabanis was among the first to draw the attention to those facts, and he ascribed their origin to the movements of the internal organs, to internal sensations, which, although unknown to the brain and to the self, *(moi)* produce, nevertheless, new ideas in it.

But we can very well explain by the modifications of the brain, primitively occurring under the forementioned circumstances, the modifications which happened to the intellectual acts. In fact, the condition of our intellect is not strictly subordinate to and connected with the perfection or with the acuteness of our senses; the senses and intellectual acts are united and necessary to each other; the former make us acquainted with the material world, and furnish the mind with the materials necessary for its labour: but the perfection of intellectual labour depends upon the development of the dispositions of the innate faculties. The sensations produced by the external world, are indeed the materials on which the functions of the mind are exercised; they are in some measure to the brain what aliment is to the stomach; but they do not influence exclusively these functions. The new born infant is only therefore compared to a blank tablet, in as much as he has never received any impressions. The very diversified results, afforded by these functions in vari-

ous individuals, have their causation particularly in the modifications of the cerebral organization; our dispositions are innate, sensations merely present them with opportunities of manifesting themselves. This is the reason why *Leibnitz* added to the axiom *nihil est in intellectu*, &c. these words: *nisi ipse intellectus.*

Bonnet, *Kant* and *Gall*, are the philosophers who have adduced the strongest and the most numerous proofs in favour of the doctrine of innate dispositions. They ascribe to them not only the intellectual faculties, but the passions also, and even what *Gall* calls *affections.* For, he remarks, if man is susceptible of joy, discontent, pleasure, pain, terror and shame, it is because there exist things which in their nature should be loved or detested, dreaded or shunned, &c.; in a word, every thing in us seems to be intended for this exterior world.

ARTICLE 5.

Of the Circumstances which Modify the Brain, and its Functions.

After the research and determination of the organ of the physiological functions, the deviations of organization naturally present themselves for our study, and the modifications which it experiences according to certain circumstances, ages, sexes, temperaments, peculiar hygienic agents, such as climates, diet, profession, education and civilization. With idiots the brain is generally small, imperfect especially towards the frontal region; and in the very rare cases in which the formation does not materially depart from that of other men, idiotism

may be explained by the absence of memory, without which no ideas are stored up, without which, again, we can neither compare nor reason.

Very few authors contend in our days that the brain is not idiopathically or sympathetically altered in alienation, and febrile delirium; and that in consequence of these alterations, it is not modified in its functions.

During fœtal life the senses are precluded from external impressions; however the brain may be accessible to morbid internal sensations, to pain, and which may be manifested by movements.

Immediately after birth, touch exists; the other senses successively appear in the following order; taste, hearing, sight, smell; in a few weeks they become more and more perfect. The brain grows progressively; according to M. *Gall*, the cerebellum, the seat of physical love, begins to grow and enters into action at the age of puberty, the period of the appearance of this passion. The encephalon only acquires its complete development between the ages of twenty-five and thirty-five. Then the intellectual and affective functions have arrived at their point of maturity and strength. It is at this period that the qualities of the mind are the most brilliant, and those of the heart most benevolently disposed. The brain preserves for a few years after this period its former qualities, but soon participates in the general weakness of the other organs.

However, the experience of old men being greater than that of young persons, their judgment being less influenced by the passions, they are better calculated to advise, guide, and govern. Indeed these are attributes which have been granted to them in all ages. In decrepitude, sensations are blunted,

memory is absent, judgment itself is impaired, and tend to assimilate itself to what it is in infancy.

The brain in woman presents a volume and a development of parts, generally different from those we find in man. The intellectual faculties predominate in man, the affective faculties in woman: she feels more than she thinks. It is especially the instinct of love and attachment that characterize her; this is her most charming attribute; this is what renders her so interesting in civilized society. She consoles herself in the bosom of her family for not being able to do much for the advancement of science, or to take any part in the administration of the state; she finds in it a relief to the humiliations and chagrins, with which a *master*, who is forced on her by nature, often overwhelms her.

The brain is the sole organ of moral functions; it is the only organ the modifications of which immediately cause those of the intelligence; in it only reside the principal organic conditions of the moral faculties. If the brain is sometimes influenced by the other organs, it is accidentally, momentarily, and sympathetically; however, there are physiologists who admit the sympathetic influence between organs to exist only in a pathological state; they contend against that of healthy organs, in other words, against the doctrine of temperaments. According to them, in a healthy state, an organ can not produce any change very appreciable in the organism, and break the harmony primitively established; the organs (we suppose them always in a healthy state) exist and live separately, if we except, remarks M. *Georget*, the brain; they only have a slight influence on their fellow organ of the same functions. When the muscular, or digestive

organs are observed to have a predominating growth over that of the other organs, this growth is concomitant with the cerebral weakness; and let us remark, that this latter is primordial. In fact, it is because the brain is not agitated, fatigued with profound meditations, and violent passions, that this predominance has occurred.

These groups of characters, that the favourers of the doctrine of temperaments ascribe to the ascendency of the sanguineous system, bilious system, &c., sometimes exist, it is true; but then we must not seek the cause exclusively in the circulatory and bilious organs, which, in a healthy state, have separately and individually, little influence over organization generally; but it should be referred to the brain, which keeps up intimate relations with every part of the machine. Thus in children, in old men, in idiots, and the insane, we can explain the very slight manifestation of temperament by the want of energy in the brain; but it may be asked, why the temperament of females, who are not subject to vapours, are so little characterized? but why, on the contrary, irritable persons, those whose passions are violent and strong? why learned men and men of letters, plunged in daily meditations, are, as it were, stamped with a common character, have an attenuated body, and a digestive and a muscular system little developed? Lastly, *Zimmerman*, that distinguished observer, leads us to understand, in several passages of his works, quoted by *Georget**, that the characteristics of temperaments are owing to the influence of the brain; and *Tissot* informs us, positively, that this celebrated

* See Physiology of the Nervous System, v. 1, page 205.

man intended to prove that the different temperaments of individuals, or even of nations, resided in the nervous system.

The condition of the atmosphere and of localities, the difference of which constitutes those of climates, powerfully influence the moral state of man. The air, the chymical analysis of which has been found by experiments, identically the same in every part of the globe; and indeed it is only by its being loaded with miasmata, and by its different degrees of density, owing to heat and cold, that it exercises its influence.

The distribution of the soil, and the nature of its productions, modify the moral qualities of the aborigines. These circumstances, and the surrounding objects, naturally invite to the acquirement of that kind of knowledge which is relative to them, and produce peculiar taste and disposition; the life led by the inhabitants of the plains, mountains, and the banks of rivers, is too well known to need being mentioned here.

The productions of the mind are impressed with a kind of stamp communicated to them by the climate; compare, for instance, the poetry inspired by beholding the beautiful sky, and smiling landscape of the eastern regions, with that elicited by the thick fogs, and by the gloomy land, deprived of vegetation, of the Scandinavians. The imagination and language of the inhabitants of the east is ardent as their sun; whilst those of the northern tribes seem to participate in the character of their frozen regions.

The modifications of the mind have been materially influenced by those of the physical properties, in the different races or varieties of the human spe-

cies. It is now demonstrated that it is but one species, and that, like plants transplanted from one climate to another, it has assumed various forms in the different regions of our globe; therefore the influence of climate over the morals of men must be incontestably admitted.

To climates, special productions are to be referred, so that diet, another modifying cause of the physical and moral condition of man, is partially subordinate to them. Its effects are among the most remarkable, according as man uses flesh, condiments or stimulating beverages; or according as he shall use white meats, vegetables, aqueous drinks, the functions will be, generally speaking, active or languid. Who is ignorant of the influences of wine and coffee.

When, by succession of ages, nations have been stamped with these modifications, such nations retain and transmit them by means of generation; hence results the moral type of races and of nations.

The development and force of the organs of our economy are increased by exercise; that of the intellectual organ is no less demanded from man than that of the instruments of the other functions; he ought only to exercise indefinitely the intellectual faculties, and carry them to the highest point of perfection; as to the affective faculties, he ought to cultivate them all in whatever they present advantageous to the individual and to society, and curb them in those parts which are disadvantageous. Education is the science which has for its object the attainment of this double aim; it is naturally divided into two branches; the one treats of the mind, the other of the passions and affections.

Since life is too short to cultivate all the faculties, we ought to select that for the development of which

the innate dispositions are the most evident; in this consists the great talent of the instructer. Moreover, the time employed for the attainment of a knowledge for which the brain has received but little predisposition, is nearly lost when forced upon a child. Education, therefore, ought to be different for both sexes; we should seek, particularly, to develope in females the moral faculties, and not those of comparative sagacity, of mathematics, &c. We should also vary it somewhat for each individual.

The repetition of the same acts, or exercise, having for their natural consequence the development of the organ which executes them, it is evident that the more the brain is exercised in the various professions of civil life, the more it will become strengthened in the execution of its functions; and as these professions have for object, to exercise one faculty oftener than the others, this will acquire a positive predominance; it is by doing a thing, that we learn how to do it well.

The different degrees of civilization, and religions, have also on the functions of the brain an influence easily to be conceived; but we shall not treat of them in a book of this size.

ARTICLE 6.

Of the means of appreciating the mode and extent of the moral faculties.

The exercise of a function is the easier and more regular, as the organ appropriated to it, is more extensive, more developed, and at the same time more stimulated and excited.

Such are the two elements, according to which, the extent and energy of a function may be valued.

We are aware that the first, or the material magnitude of the organ, is the only one appreciable; it is therefore, in order to judge *a priori* of this development that most of the diverse methods of divination of the intelligence have been established. However, there is a mode which does not bear upon these ideas, it is that of *Lavater*, who seeks in the expression of the physiognomy, the measure of the moral and intellectual faculties. Obviously the seal of the passions, of mind, or of idiotism and imbecility, is often stamped on the countenance, which, for this reason, was called the *mirror of the soul.* The brain determines the expression of these acts by the optic nerves and by those which animate the muscles of the nose and mouth. *Charles Bell*, and since, M. *Magendie*, have proved, that this occurred principally through the facial nerve.* The repetition of the same intellectual operations has in consequence that of the same expression of the face, and in the course of time a fixed physiognomy may be the result. But *Lavater* has gone too far with his system, and most certainly he was wrong to draw inductions and native dispositions from the original formation of the face.

We have combated the doctrines of temperaments; we have proved the slight influence that healthy organs exercise over the brain; it would therefore be contradictory, and moreover illusory, to take the marks of these supposed temperaments for those of the mind and of the passions. It is only in the degree of the development of the brain, that most authors have looked, and with good reason, for that of the psycological functions.

* See his Essay read at the Institute.

Aristotle formerly considered the absolute development of the encephalon as that of the intellect. Afterwards the volume of the brain compared with that of the body was taken as a rule; finally, others, at the head of whom we find *Sœmmering*, believe, that they have found this measure by comparing the cerebral mass with that of the medulla oblongata or with that of the nerves. These methods of ascertaining the relative magnitude of the brain, being of a difficult application, can not be laid down as a law, because of the numerous exceptions pointed out by comparative anatomy.

Every one is acquainted with the angles by which *Camper* and *Daubenton* pretended to measure the organ of moral functions; the former applied the angle on the face, formed it by drawing a horizontal line on a level with the foramen magnum occipitis, to the superior incisive teeth, where it meets a vertical line parallel with the face and forehead; the latter drew a line from the inferior margin of the orbit to the condyles, and another vertical line from these condyles to the sinciput.

The facial angle of *Camper*, and the occipital angles of *Daubenton*,* give only by their degree of opening, the projection of the brain towards the forehead or the occiput; they neither give its height nor its breadth. There are circumstances of the volume of the brain which cause the opening of those angles to vary: such is the thickness of the bones relative to both of these methods; and particularly for that of *Camper*, the projection of the maxillary bones and of the frontal sinuses. Besides, as may

* The denomination of these angles is derived from the places where they are applied.

be readily foreseen, even if these methods were well founded, they would be capable only of measuring respectively, the former the anterior parts, the latter, the posterior. According to M. *Gall* and other physiologists, these two parts are respectively allotted, the one to the intellectual, the other to the moral faculties.

Our much celebrated *Cuvier* proposes a sure method of judging the extent of the brain; but, unfortunately, it can not be applied to living animals. He proposes the comparison of the extent and figure of the area of the cranium and face. For this purpose he saws vertically the cranium and the face on the median line. This area has been found larger in the European; it diminishes in the Calmuck, the Negro, &c.

M. *Gall*, in a celebrated system, abandoning the consideration of the brain as a whole, has sought to appreciate, by the examination of the extent of surface, and of projection of the various departments, that he assigns to our faculties, our proneness, or our aptitude for this or that faculty; hence the names of craniology, cranioscopy, that he has bestowed on them.

In admitting as indisputable the demonstration of the plurality of the organs, and assignation of their seat, the idea is consistent with reason; for the cranium is moulded over the brain, at least as long as the latter has not acquired its full growth. When the brain undergoes any modifications in its volume in old age, it is only on the internal table that it is perceptible, and not on the external: therefore this art can not be applied to old persons. Again, the irregularity of the muscular and bony projections renders it of a very difficult application. Indeed our

philosopher, being aware of these difficulties of the three fundamental points of his doctrine, this latter is the one on which he insisted the least; however, he has brought forward so many facts relating to the following propositions, that many persons admit them:

1st. The cranium of idiots is principally depressed on the anterior parts.

2dly. That of woman presents a larger development towards the occiput, the seat of the affective faculties, than towards the forehead, which is the seat of the intellect.

3dly. Most men of great genius have a vast forehead: the inspection of antique statues leads us to believe that this fact had not escaped the sagacious observation of the ancients. But when an attempt is made to enter into the details of cranioscopy, M. Gall confesses his incapacity and the fallibility of this science, in most cases; in this respect, the ideas of this great observer have been singularly exaggerated, and very bitterly and unjustly criticised.

CHAPTER III.

OF LOCOMOTION OR VOLUNTARY MOVEMENTS.

The name of locomotion has been given to the functions by which man, from the impulse of his will, moves his body in part or altogether in order to establish relations with the beings surrounding him.

ARTICLE 1.

Locomotive Apparatus.

This apparatus in man is composed of *passive* organs, (the bones,) and of *active* organs, (the muscular and nervous apparatus.)

Bones. This name is given to an assemblage of hard organs, united with each other by bands which form of them a whole, giving to the body, of which it is the frame, its shape and solidity. They are divided, according to their form, into flat bones, particularly intended to form the splanchnic cavities; into long bones and short bones, which are met with especially in the limbs. Their surface presents to our consideration, 1st, eminences or processes which are distinguished, according to their use, into *articular* and processes *of insertion,* of *reflection* and *impression;* 2dly, cavities which are likewise divided into *articular,* and into cavities of *impression,* of *insertion,* of *reception,* &c.

Bones are composed of an areolar organic tissue, in which is deposited an earthy salt to which they owe their hardness; they receive arteries, veins and nerves. They are covered, on their exterior, by a fibrous membrane called periosteum. The interior of boues is filled with porosities and often is hollowed into a caual which is lined with a cellulo-vascular membrane, which contains the medullary fat.

The places where the bones come in contact with each other, assume the name of articulations; nevertheless, *Sœmmering* gives this name to those only, which execute movements. They are generally divided, 1st, into *synarthrosis*, which comprehends sutures and gomphosis; 2dly, into *amphiarthrosis;* when the bones are united by a fibro-caletagenous substance; 3dly, into *diarthrosis*, which includes the enarthrosis, arthrodia, planiform, diarthrosis, ginglymus and trochoides. Generally speaking, a thin cartilaginous lamina tips the articular surfaces, which are sometimes separated by fibro-cartilaginous platcs, and which are held in their places by fibrous attachments; generally, a synovial membrane also lines the interior of the articulation and favours its motion.

The union of all the bones constitutes a movable frame, which gives support to all the other parts of the body. We consider in it, with respect to locomotion, the head, which is articulated in a movable manner at the cxtremity of a long osseous column, composed of a series of small bones, united with each other by a very strong fibro-cartilage, which admits only limited motion, and which, however, being multiplied by each division, permits a very considerable movement of the whole shaft; this column, called *spinal*, is the principal lever of the

body; it is intrusted to support anteriorly, capacious splanchnic cavities, and to transmit their weight to the inferior or abdominal extremities; it contains, within its canal, the most important part of the nervous locomotive system. The inferior extremities are species of folding columns intended to transmit to the ground the weight of the body; the superior or thoracic extremities, on the contrary, are truly the organs of apprehension: they are levers breaking into folds, which allow of very extensive and very multiplied motions.

Of muscles. These include all the parts of the animal, which execute the contraction, on which movements depend; they are composed of fasciculi, more or less voluminous, and more or less red, attached by their extremities to the surface of bones to which they impart motion. We are already aware that the muscular fibre is one of the three elementary tissues; let us now see what has been said of its intimate nature. *Heister, Cowper, Willis, Hamberger,* &c. entertained the opinion that it was hollow; some believe that it contains a spongy matter; others think that this fibre mingles with the nerves; others again believe it to be solid, and this last opinion has prevailed.

It is from the assemblage of these elementary fibres that the muscular fasciculi result, the power of which is relative to their volume and to their length; their extremities terminate in tendons, or aponeuroses; they never attach themselves to the bones without the intermedium of these parts; and they receive a great quantity of blood vessels and nerves.

Of nerves. The nervous system, which animates the muscles, comprehends the spinal marrow and

the nerves which arise from it; and, moreover, according to some authors, who ground their opinion on that of M. *Flourens*, the cerebellum, is the regulator or the organ which rules movements; finally, the brain itself, by the fact that it regulates all the voluntary actions, participates also in locomotion, as is demonstrated by a multitude of experiments and morbid alterations; but determination seems to be particularly allotted to it. We have treated of this subject elsewhere. (See the article of sensations.

Of muscular contraction generally.

According to the various opinions that physiologists have formed for themselves of the nature of the muscular fibre, they have built up different hypotheses about the nature of its contraction; thus, those who have considered this fibre as being tubular, have concluded that its contraction is solicited by its being filled with blood or with nervous spirit, or by an effervescence being developed in its cavity. *Haller* believed that contraction was a property inherent in muscles; the ancients explained this phenomenon by a mechanical traction of the muscular fibre exerted by the nerves; it is well known that the researches of Messrs. *Dumas* and *Prévost* lead to this opinion.

From this diversity of opinions we may conclude, that the nature of contraction is unknown; let us therefore confine ourselves to what observation demonstrates. When a muscle contracts, we observe the following phenomena: 1st, its extremities draw nearer to each other, consequently its fibres shorten; 2d, it often acquires a very considerable hardness,

and very great strength; 3d, it is still believed that it augments in thickness, notwithstanding the contradictory experiments of *Borelli*, *Glisson*, &c.; 4th, the intensity of its contraction varies at pleasure, anger imparts to it energy; 5th, the bones obey passively these contractions in the direction admitted by their articulation; 6th, finally, the muscles are fatigued, need repose, and relax; nevertheless, some authors consider the relaxation of the fibre as being an active state, but we are aware that very often muscles fall into this condition in spite of our will; 7th, we can still add among the positive facts, that the integrity of the arteries and nerves, which are distributed to a muscle, is indispensably necessary to its action.

ARTICLE 2.

Of Station.

This is a function which is either passive or active, by which the different parts of the body are kept stationary, and consequently the under parts are constrained to bear the superincumbent weight. The position is *passive* when the body is stretched at full length on the ground; it is *active* when the trunk is borne on its inferior extremities.

Biped Station. Man does not form a single lever from head to foot; he presents a great number of joints, which constantly tend to refuse each other mutual assistance. *The head*, fixed on the vertebral column, presents a lever of the first order, the main shaft of which is directed forward, so that it tends to flex in this direction; but the numerous muscles of the posterior part of the neck, and the posterior cervical ligament, maintains it in equilibrium. *The*

spine: the superior limbs, the enormous weight of the organs contained in the thorax and abdomen, finally, the head itself, weigh on the vertebral column, and would inevitably bend it forward, if to the solidity of its organization were not added numerous muscles extending all along its posterior sides, counterbalancing the weight of the anterior parts. The inferior vertebræ are fixed to the sacrum; they successively serve afterwards as a point of support to the superior; each of these vertebra separately represents a lever of the first order, which tends to carry it forward, the fulcrum being their fibro-cartilage union, and the power the muscles which are inserted in their apophyses, and which counterbalance the weight fixed on its anterior part; by this mechanism the spinal column is converted into one single lever, which transmits all the weight of the superior parts, through the medium of the sacrum, to the pelvis, which is articulated with the latter in an immoveable manner; so that we may very well consider it as a base added to the great lever of the spine.

The trunk stands in equilibrium on two rounded pivots (*the heads of the femurs*); but this equilibrium is owing to the combination of several powers; on the one hand, the inclination of the pelvis, and the weight of the superior parts gives again to the body a tendency to fall forward; but on the other hand, the large muscles of the buttocks, and the flexors of the leg, counterbalance advantageously this improper tendency.

The femur transmits to the tibia the weight it has just received; the articulation of these two bones, although pretty solid, would nevertheless be too narrow to form a base capable of maintaining the

equilibrium; and the thigh would flex on the leg if this effect were not prevented by the extensor muscles of the leg. Here the muscles act as a lever of the third order, and almost parallel to the bones; however, the patella in some mèasure diminishes this inconvenience.

The weight of the body falls perpendicularly upon the tibio-tarsal articulation, which is narrow and very movable; thus the body again inclines to fall forwards. In this case the body is indebted to the muscles of the calf of the leg for retaining its vertical position.

Finally, the foot transmits to the ground the whole weight of the body. Its anatomical structure and its breadth, are very well calculated to insure the solidity of the standing position, in which, moreover, it takes an active part; it presents, in fact, a slight concavity from before backwards, and contracts as it were to grasp the ground.

Such are the muscular actions which keep up the body in a vertical situation; we might likewise consider them from below upwards, and we could then perhaps appreciate even better, the mutual support or assistance they lend each other.

We are aware, in mechanics, that a body retains its erect position whenever the part on which it rests on the ground is sufficiently extensive for the vertical line of this body to fall in the space circumscribed by its base; and the station is the more solid the larger the base. This law is applicable to man, and we remark in him a series of bases laid over each other, which become larger in proportion as we descend lower down, so that they represent a kind of pyramid; but a very remarkable circumstance is, that they become larger principally on the

side where the body has a tendency to fall; which may be easily ascertained by considering the relations of situation and of proportion which exist between the *atlas*, the *sacrum*, *the interval between the two acetabula, that of the two femurs*; finally, *that again which is circumscribed by the feet*. These bases, in fact, are more and more anterior and capacious.

Notwithstanding what some philosophers have observed, the erect station is natural to man. The horizontal situation of the occipital condyles; the weakness of the muscles of the neck, and of the cervical ligament; the direction of the face, eyes, and nostrils; the aliments which, in the position of quadrupeds, would fall from the mouth; the covertures of the vertebral column, which extend the limits of the centre of gravity in the erect position; the length of the inferior extremities, &c. All his organization concur to prove this assertion.

Soliped Station. It is very difficult and not firm, and the reason is because the base, being very narrow, the trunk bends on one side; at this time the corresponding muscles of the hip must then display their utmost energy.

Kneeling. The body rests on the patella, the base of sustentation is extended backwards, but do not exist forward; hence the extensor muscles of the trunk are soon overcome.

Sitting Position. The weight of the body is transmitted to the ground through the pelvis. This station is very fatiguing for the abdominal muscles when we sit on the ground without any thing to lean against; it is less fatiguing when sitting on a high seat: in this case, the body has less tendency to bend backwards; finally, when there is a back to

the seat, this position is preferred by man whilst awake: it is almost passive.

When to this position we add the flexion of the thighs and legs, and that the hands are crossed over these parts, then the position is called *squatting.*

Standing on the head. It can not occur but with the help of the arms, which then circumscribe a large base of sustentation.

The recumbent posture requires no muscular exertion.

Walking is the ordinary mode of progression; for this effect each of our inferior limbs is alternately carried forward, whence results the *step;* their succession constitutes *walk;* the mechanism is as follows: man slightly bends forward on one of his limbs, then he successively flexes the articulations of the other; the foot is withdrawn from the ground, is carried forward, and is again laid down, beginning with the heel; the body soon inclines over the other limb, which is now anterior: afterwards the one which remained behind leaves the ground, its articulations are flexed, and by movements analogous to the preceding, is carried in its turn and placed before the other. In the meantime, the pelvis performs alternate movements of rotation on the head of the femurs, a succession of which forms zig-zags, very remarkable in females, on account of the width of their pelvis. Walking backward is performed nearly in the same manner, with the exception that the leg is carried backwards, then the toe is the first to touch the ground. When we ascend, the limb which is carried forward must raise the body contrary to the law of gravitation; for this effect the muscles of the thigh are strongly contracted; but this movement is commonly aided by inclining the body forward by the action of the

anterior muscles of the trunk, which then contract the chest and induce panting.

In descending, the flexion of the limbs is not so great; the feet are drawn downwards by gravitation; and the body would fall forward, if it were not for the continual contraction of the posterior muscles of the trunk, which renders this mode of progression fatiguing.

In all these different kinds of progression the line of the centre of gravity is alternately transferred from one limb to the other, and the arms perform the office of levers.

Leaping. The body of man may be propelled in the manner of passive projectiles, by the sudden and as it were convulsive expansion of the articulations which have been previously flexed. The head, the trunk, the pelvis, the thighs and the legs are flexed; the extensor muscles are all at once violently contracted, especially in the inferior extremities, and produce an effort of projection which raises the body from the ground in a perpendicular direction. If in effecting this instantaneous straightening of the joints, the trunk be inclined in any direction whatever, the body is not only raised from the ground, but it describes a curve which conveys it to a greater or lesser distance. This kind of leaping is generally preceded by a *run*. *Borelli* compares leaping in man, to the distension of a watch-spring suddenly distending. *Barthez* thinks, contrary to the opinion of this physician, that the ground has no influence in the production of this phenomenon; nevertheless we jump very well from an elastic surface, and very indifferently from a movable sand, &c.

Running. Some physiologists have considered

it to be a series of alternate leaps; and most of them regard it as the result of the two preceding exercises, walking and jumping; this is evidently what we shall prove by its mechanism. At first, the body is slightly bent forwards, one of the limbs is thrust quickly forward, and while it is yet in the air, the other instantaneously extends its joints, consequently it imparts a movement of projection to the body; from this moment the limb carried forward falls to the ground, receiving all the weight of the body, and is immediately withdrawn from it by a mechanism analagous to the preceding, i. e. in quickly contracting to throw the centre of gravity on the other leg.

Thus, independently to steps similar to those constituting walking, we observe in running the movement of projection, during which the centre of gravity is moved along suspended in the air. Most of the muscles, which fix the lumbar regions and the pelvis, receive their point of support on the chest; hence the shortness and acceleration of respiration.

Of Swimming. This is a mode of progression less natural to man than the preceding; his physical organization has not been calculated on the laws of hydrostatics; its specific gravity is generally greater than that of water; thus the science of swimming consists in multiplying the surface of the body by extensive motions so as to displace a greater volume of this liquid.

Whilst the body is extended on its anterior surface, it advances on the water in the following manner: the hands drawn before the chest, are extended out forming a point; the thighs and legs, at first flexed, are briskly extended, strike the water backwards, and thus impart a slight movement of progression to the body; at the same time the superior

limbs are extended, pressing the wave in the manner of an oar, the legs are drawn near, parallel to each other; then when the progression takes place, the limbs are again flexed and brought back to their former position; the superior limbs, in the meanwhile, describe a circle which press the water under the trunk, and raise it more or less over its surface. The muscles of the spine are in a continual state of contraction in order to fix the vertebral column and raise up the head. Swimming on the back requires little or no exertion; the anterior muscles of the trunk only are slightly contracted.

ARTICLE 3.

Mechanism of the upper Limbs.

They have justly been considered as the organs of *apprehension;* in fact, the superior limbs unite to a pretty considerable force, an astonishing mobility, either in the shoulder, the movements of which are very extensive, or at the elbow where the two bones move on each other by numerous muscles, or finally at the hand, the extraordinary mobility of which is so great a resource in the arts. Where is the stubborn man who will still maintain that these limbs are intended for walking, while we behold the delicacy of the movements of the fingers in drawing, writing, and music? In the action of *pushing, pulling, grasping, squeezing, carrying, parrying,* &c., the superior limbs are in a state of greater or lesser activity; but it is not the object of this work to enter into the description of each of these movements in particular; however, it will be easy to remedy it by the knowledge we have already acquired of the mechanism of man.

CHAPTER IV.

OF EXPRESSIONS.

MAN, above all animals, enjoys the faculty of expressing his sentiments, and of manifesting his passions; his expressive means are gesture and speech.

ARTICLE I.

Gesture.

This name is given to the silent, and as it were, automatical expression of our sentiments; the face is the principal seat of this language of action, the multiplicity of muscles which compose it, and the particular organs which are met with in it render it very well calculated for this purpose. The infinitely varied movements of the forehead, eyes, eyebrows, lips, &c., the change of colour and of temperature of these parts suffice to keep up long conversations, and to express the most tender feelings. In a word, the face, as it is commonly remarked, is *the mirror of the soul.* The gait, the attitudes, the movements of the limbs, the state of respiration, are also as many phenomena which betray our passions.

From these various gestures spring a peculiar language, which is called *affective* or *involuntary;* it is composed, as we observe, of a great number of

phenomena which unavoidably occur in us, and which disclose the state of the heart and of the mind. Are not *laughter*, *smiling*, *crying*, *sobbing*, *sighing*, *gaping*, *looking*, *pause*, *&c.*, expressive of *gaiety*, *sorrow*, *love*, *ennui*, *terror*, *hatred*, *despair*, *jealousy*, *&c.*?

In vain should we seek to dissemble these mimick phenomena; they break forth in spite of ourselves, but in different degrees, according to the state of sensibility. Their cause is unknown. M. *Gall* thinks, that their production has some relation with the state of the organ in which is produced the sentiment that induced them. In some cases gestures are voluntary; they ordinarily accompany speech, and then constitute a part of conventional language.

ARTICLE 2.

Of Voice and of Speech.

The voice is a sound produced by the vibrations of the air expelled from the lungs, modulated by the larynx.

Organ of the voice. The experiments of *Bichat*, and the observations of fistulous opening of the trachea, collected by *Magendie* and *I. Cloquet*, in which the voice was produced only when the fistulous openings were perfectly closed, prove, in an incontestable manner, the larynx to be the organ of the voice.

The larynx is a small hollow symmetrical apparatus, composed of an assemblage of parts movable upon each other, placed on the median line of the neck, below the os-hyoideus, on a level with which it opens in the back part of the mouth; it is continuous with the cavity of the trachea. There

enters into its organization cartilages articulated with each other in a movable manner, ligaments, muscles, membranes, vessels, nerves and glands.

The cavity of this organ presents the instrument proper to the voice; it is composed of a triangular fissure, capable of various dimensions (*the glottis*), and the sides of which are formed of four membranous folds known under the name of *vocal cords;* two of these folds are superior and form the opening of the larynx; they are separated from the two inferior by two small scaphoid excavations, called the ventricle of *Morgagni;* all these parts are lined with a mucous membrane.

Phonation or voice. The air, expelled from the chest in expiration, reaches the larynx, where it meets with the vocal cords, which are then more or less extended by the internal muscles of this organ; it receives in its passage vibrations from which the sounds result, then it escapes through the mouth and nasal passages. *Galen, Fabricius, (D'Aquapendente,)* and *Dodart*, established that the air, as we have just remarked, was the sonorous body; *Ferrein* considered, on the contrary, sound as proceeding from the vibrations of the vocal cords, and consequently compared the larynx to a stringed instrument. M. *Richerand* believes that these two causes may be united for the production of this phenomenon, whilst most physicians consider the larynx as a wind instrument with a reed or mouth piece; such is also the opinion entertained by M. *Magendie.* According to this opinion, the glottis represents the reed or mouth-piece of the instrument.

Power of sound. This is, as we know, subject, to a certain degree, to the will, but the quantity of

the air expired, the diameter of the larynx, and the disposition of the parts through which the sound escapes, are so many causes which singularly modify its power; thus, for instance, in females, the capacity of whose chest, and the diameter of the larynx, are less than in men, the voice is also much more delicate.

Tone. The human voice is susceptible of a multitude of inflexions, which constitute different tones. *Galen* ascribed the variations of the voice to various lengths of the trachea, and to the degree of occlusion of the glottis; *Dodart* acknowledged this last cause only; *Ferrein* attributed them to the extent and degree of tension of the vocal cords, and hence the different number of vibrations produced in a given time. Messrs. *Biot* and *Magendie* have observed the reality of these vibrations; they communicate moreover a tremor to the larynx, and of which we may convince ourselves by producing deep sounds; the degree of opening of the mouth evidently influences also the variations of the voice. The extent of the human voice embraces nearly three octaves.

*Timbre.** It varies infinitely; thus the voice of women is sweeter, and possesses something more touching than that of men, the principal character of which is coarseness: physiologists are entirely ignorant of the causes of these phenomena.

Ventriloquism. This is a peculiar and extreme-

* There is no word in the English language which conveys precisely the meaning of the French word *timbre, tune* does not translate it; but it means the peculiar quality of the voice, or the peculiar quality of sound of a metal, hence, the *timbre* of a bell, &c. TRANS.

ly remarkable illusion of the voice, which, according to Messrs. *Dumas* and *Richerand*, is owing to the sound being at first formed in the larynx, and then re-echoed in the chest, whence it issues slowly. The voice has evidently sympathies with the sexual organs; it is a remarkable fact that the castratos have an effeminate voice, while erotic women acquire the coarse voice of men, &c.

Of speech. This is nothing else than the voice articulated by the various parts which compose the mouth, and especially by the movements of the cheeks, lips and tongue. Here we are struck with admiration in thinking what must have been the power of the human intellect, in order to be able to associate our ideas to a collection of articulated sounds, *words*, the union of which forms *language*, properly so called, or *conventional language;* but so far we speak only to our contemporaries, it was necessary to communicate with future ages, and it is again to his genius that man is indebted for this great step towards his perfection. For this effect, words have been reduced to a certain number of elementary sounds which have been represented by signs or letters, the union of which constitutes writing. Letters are divided into vowels, the pronunciation of which is soft and natural, and into consonants harsh and difficult to pronounce; hence, consequently, the harshness of the language in which these latter abound; and on the contrary, the softness, delicacy, and harmony of those which employ most vowels. Sometimes man expresses his passions by *singing*, or modulated voice, with or without words; *declamation* is a modification of it; every one is aware of the power of these means of expression.

There exist, in pronunciation, sounds which are

sometimes defective, owing to several imperfections, as mal-conformation of the roof of the mouth, or the uvula, the loss of teeth, and often to education, &c. These defects consist in *stammering*, *lisping*, *stuttering*, &c. *Dumbness* consists in a total privation of speech; it may either be congenital or accidental.

CHAPTER V.

OF SLEEP.

Sleep may be defined to be the state of repose of the organs of the senses and of voluntary movements, or the periodical and temporary suspension of the functions which establish our relations with the exterior world, during which man repairs the losses which he has sustained, and recovers the faculty of acting.

When watching has been protracted fifteen or eighteen hours, a lapse of time however variable, according as the body has undergone more or less muscular or intellectual fatigue; according to habit and age; lastly, according to the presence or absence of exterior or interior exciting causes, we experience a peculiar, indescribable sensation, but which every one knows by experience, (*want of sleep;*) the body feels wearied, the sensations are benumbed, the superior extremities are stretched out, the eyelids close, respiration slackens, and is accompanied with yawning; all these sensations are soon extinguished, the intellectual and moral faculties are obliterated, the body assumes a posture semi-flexed, and in such a manner that all the parts may be mechanically supported by the ground.

Man in this condition has lost every consciousness of his existence, he is *asleep.* From this mo-

ment he no longer exists but for himself, his vegetative or organic functions still continue; it is even believed that they increase in energy; digestion is more active, respiration deeper, the pulse slower, but full; absorption, nutrition, and secretions are more active (*motus in somno intrò vergunt, somnus labor visceribus.—Hipp.*) It was probably owing to this reason the ancients took their principal meal in the evening; it is perhaps for the same cause that animals go to sleep after having eaten, &c.; nevertheless, caloric is evidently diminished during sleep, (*cum somnus invaserit, corpus frigescit,—Hipp.*) Such is the condition of the organism during this precious rest; in the course of seven or eight hours there results a favourable change, which is manifested in all the functions at the moment of *awaking;* this moment is announced by the successive return of intelligence, internal and external sensations, and by muscular action; stretchings, gaping, and sighing, call for the nervous influx in all the parts, and completely dissipate torpor; at this time wants are felt, and particularly those which invite to evacuate the various secretions; finally, man returns again as it were to life, with renovated energy.

The duration of sleep has no determined period; it varies infinitely; first, according to age:* thus children sleep more than adults, and these latter

* *Buffon*, M. *Richerand*, and other physiologists, believed that the child sleeps continually during the nine months which precede its birth; i. e. during its intra-uterine life. But notwithstanding the imposing opinion of these great men, I believe, that in order to be able to go to sleep, there must first exist physical losses which require restoration; in fact, we must have previously been awake.

than old men; 2dly, according to habit; 3dly, according to the physical and intellectual activity of the preceding day: men sleep always longer in proportion as labour has been longer borne and more intense, because the losses and exhaustion have been greater; 4thly, finally, according as the nervous system is in a more or less complete state of repose.

The soundness of sleep is no less variable; and with reference to this we may distinguish it into complete sleep; it is the one already described; and into incomplete, that is to say, the one during which some animal or intellectual acts are performed; such are the irregular movements which agitate the body, dreams which are nothing more ordinarily than a mere incoherent labour of the brain, without the will participating in it. Hence, an association of ideas more or less fantastical, often relating to the intellectual and physical labours of the preceding day. Dreams are sometimes accompanied in some persons with expressive phenomena. Finally, in some circumstances the functions of relation seem to preserve their integrity, and to be directed by the mind; this constitutes *somnambulism*, which has elicited observations as surprising as extraordinary.

The explanation of the nature of sleep, has given rise to several hypotheses. *Aristotle* ascribed it to the cooling of the heart, by the absence of a humidity which was before carried to the brain. *Homer* and *Plato* considered it as the rest of the soul, required by the fatigues of the preceding day. *Willis* ascribed it to the compression of the brain. Modern physiologists, who admit the opinion, question whether the compression is active or passive. M.

Broussais is of the former opinion. *Avicenna* believed that there was a suspension in the action of the animal spirits. Most physiologists of our days, ascribe sleep to too great an expenditure of the sensitive and locomotive principle; finally, some authors, in common with Barthez, consider sleep as an active function, (*somnus est functio activa principii vitalis;*) but we have already remarked that the character of a function was to possess an instrument or organ; where are we to look for that of sleep?

SECOND CLASS.

FUNCTIONS WHICH ARE SUBSERVIENT TO THE PRESERVATION OF THE SPECIES.

CHAPTER I.

OF GENERATION.

THE functions which we have just treated of show, in their relation, an admirable foresight of nature to secure the existence of the individual; but this was not sufficient to perpetuate the human species; having condemned him to die, she was obliged to provide for his reproduction; hence, after the preservation of the individual, she has bestowed all her solicitude in a more important one, that of the species. Generation, an admirable faculty, without which the universe would no longer exist, is trusted to organs belonging to both sexes; of which they establish the principal differences; it comprehends or embraces several distinct stages, *copulation*, *pregnancy*, and *lactation*.

ARTICLE 2.

A. *Genital Apparatus of Man.*

It is composed of the organs of *fecundation*, and those of copulation; we shall examine them briefly.

Testicles. These are two ovoidal glands, situated below the pubis in a prolongation of the skin, called scrotum. Their parenchyma, like that of the other glands, is composed of blood vessels, which bring to them the materials of secretion, and of excretory vessels. These are very small, winding, very flexuous, and are named seminiferous; their number being 62,500; their diameter is the two hundredth part of an inch; we observe on their surface, at a little distance from each other, small swellings, which have been considered as glandular; they all direct their course towards the superior part of the gland, where they unite in a whitish canal, (the corpus hygmorianum;) finally, the single canal, which results from their union, is a great many times convoluted on itself, forms, in this manner, a small oblong body, which is, as it were, superadded to the testicle, and is called, for this reason, the *epididymis.* It is from its inferior extremity that arises the cord which suspends the whole organ in its membranes; this cord results from the union of the spermatic vessels and nerves, and the excretory canal.

The parenchyma of the testicles is inclosed in a dense and strong fibrous membrane, (*tunica albuginea testis,*) which sends prolongations into its interior; it is besides contained within a membranous bag, formed, 1st, by the *tunica vaginalis testis*, an isolated continuation of the peritoneum; 2d, by the *cremaster muscle*, arising from the inferior fibres of the internal oblique; 3d, by the *dartos*, a fibrocellular layer, forming the partition which divides the two testicles; 4th, and lastly, by the skin which forms the scrotum, properly so called.

Vas deferens. This is the name given to the excretory canal of the testicles; it is acontinuation of

that formed by the epididymis convoluted on itself. After being separated from the testicles, it reascends with the vessels towards the inguinal canal, which it follows: when arrived in the abdomen, it plunges into the pelvis, and directs its course to the inferior and posterior part of the bladder; at last, it reaches the prostate, the excretor canal of the vesiculæ seminalis opens into it, then it is continued and assumes the name of ejaculator duct to the prostate portion of the urethra, in which it empties with and near its fellow of the opposite side. Its caliber is very small and its parietes very thick.

Vesiculæ seminales. These are two small areolar bags situated behind the prostate, beneath the lower fundus (*bas-fond*,) of the bladder, and exterior to the vasa deferentia; their cavity is very winding, their external parietes are formed by a *contractile fibrous coat*,* within by a mucous mem-

* Early in March, 1828, while dissecting a very stout and muscular *negro*, and before having read this passage, I met with a complete muscular coat (in the manner of a cremaster) around the *vesiculæ seminales;* serving, no doubt, as a compressor to the same; arising about the neck and terminating in the fundus: moreover, I have also observed a sphincter to the excretory ducts of the *vesiculæ seminales* and vasa deferentia, and a coat of muscular fibres along the *vas deferens*, beginning at its entrance into the prostate gland, and embracing it on all sides like a hollow cone; but, not extending beyond one or two inches. I have since read in *Cuvier's* Comparative Anatomy, (vol. 5, organs of generation) where he describes the *vesiculæ seminales* of the *elephant*, the following passage illustrative of the muscle I found in this subject: " On the internal and anterior side of each of these *bladders* is observed a peculiar muscle, which arises from their neck and extends to the middle, the fibres of which diverge in proportion as they ascend. This *muscle* contracts the *vesiculæ seminales*, by drawing their fundus towards their neck, and in this manner, causes the liquor

brane; from their anterior extremity arises a very short duct which immediately unites with the vas deferens. These small bladders serve as a reservoir to the sperm; however, the fluid, which they habitually contain, differs from it in appearance.

The *yard* or *penis*, is the last part of the genital apparatus of man; it is the organ of copulation; situated immediately below the symphysis of the pubes; it has a cylindroid form and its length is from four to five inches. It is formed, 1st, by the cavernous bodies which give to it its shape and dimensions; they begin within the rami of the ischium and pubes; they gradually approach each other and soon unite to form the body of the penis; they extend as far as the glans penis, in which they terminate by two conoid extremities. They are composed of a very strong fibrous membrane externally, which form between themselves a middle partition; it sends prolongations into the texture which fills up its cavity; this internal tissue, in the swelling of which erection consists, is composed, according to some, of a spongy structure, in which terminates the arteries and veins; according to others, it consists of a net-work of capillary arteries, veins, and nerves, supported by a cellular texture. 2d, By the spongy portion of the canal of the urethra; lodged in a furrow formed by the cavernous bodies, it constitutes the inferior part of the penis; its spongy tissue expands at the extremity of

they contain to be forced out of them." Again, in speaking of birds, which have no *vesiculæ seminales*, but which have a small *bladder* at the extremities of the vasa deferentia, he says: "it is filled with a seminal liquor, and placed sometimes between two erector muscles, the contraction of which must compress it." The *duck* is given as an example; which bird I have dissected, and found all as described by *Cuvier*. TRANS.

the cavernous body in order to form the glans penis, a kind of conoidal organ which is the seat of the voluptuous sensations which accompanies coitus. 3d, Finally, by the *skin*, which envelops every part and sends over the glans penis a prolongation called *prepuce*, which is intended to entertain its exquisite sensibility.

Secretion of the Semen. The testicle, with the blood which it receives from the spermatic artery, produces the prolific liquor; this latter passes through the whole extent of the seminiferous ducts, and the epididymis; it reascends into the *vas deferens* to the vesiculæ seminales, where it is kept in reserve till the moment when it is demanded by copulation; but, by virtue of what law does the sperm pass through so long and so winding a road? To account for this phenomenon, physiologists admit generally the continuity of the secretion, and the tonic capillary power of the seminiferous ducts. In common cases, the sperm advances slowly in the ducts through which it passes, and it is very likely that it experiences some modifications in its progress; what proves it, is, that during copulation, when its progress is very active, it is more serous, less compact in the last ejaculations than in the first; but how does it happen that instead of following habitually the ejaculator duct, it retrogrades into the vesiculæ seminales? Secondly, what modification does it experience in these reservoirs? These are questions which as yet have only been answered in a very evasive manner, and which require new researches and further investigation.

Semen, is an opaque whitish fluid, the odour is *sui generis;* it tastes salt and acrid; left to itself, it separates into two parts; the one, thick and stringy,

the other, very fluid and transparent. Some physiologists admit that it contains a gaseous something, designated by the name of *aura seminalis.* We never can obtain the semen entirely pure, it is always more or less mixed with a certain quantity of the humour produced by the glands of *Cowper,* by the prostate and the mucous membrane of the urethra.

Semen, examined by a miscroscope, appeared to *Leuwenhoeck* composed of animalcules. *Buffon, Nudham,* and *Spallanzani,* presumed they were the same as those animalcules, which are met with in all liquids. M. *Virey* thinks that these are the small vesicles which contain the real prolific fluid. Lastly, Messrs. *Prevost* and *Dumas,* who have made some researches about these animalcules, consider them as the sole agents of fecundation.

On chymical analysis, it has been found to contain in a 1000 parts, 900 water, 60 animal mucilage, 30 phosphate of lime, and 10 soda. M. *Berzelius,* has found in it the salts of the blood, besides an animal matter.

ARTICLE 2.

B. *Genital Apparatus of Woman.*

It is composed of the organs of germification, gestation, and copulation.

Ovaries. These are two irregular ovoidal bodies, situated in the pelvis, on both sides of the uterus, in a duplicature of the peritoneum; they are formed by a fibrous membrane on the exterior, and on the interior by a soft, spongy, grayish tissue, in which is found fifteen or twenty small transparent vesicles,

filled with a viscous fluid, and which are larger in proportion as they are exterior.

Fallopian tubes. These are two tortuous membranous canals, which establish a communication between the ovary and uterus; on one side they end in this organ by a very narrow orifice; on the other they terminate in a loose fimbriated body (*Pavillon*); this latter opens into the cavity of the peritoneum, it is divided into several fringes, the longest of which adheres to the ovary.

Uterus. This is the organ of gestation, a pyriform body, situated in the pelvis between the rectum and bladder; we observe, 1st, *the body*, which is superior; 2d, *the neck*, which is inferior, embraced by the vagina, into which it projects four or five lines, and which opens into it by a transversal fissure, with lips like a margin, and called the *os tincæ;* 3d. Finally, *the cavity*, that of the body has the form of a curvilinear triangle; it is at its two superior angles where the fallopian tubes enter, the inferior angle terminates in the neck; this latter, slightly excavated in its centre, presents nothing very remarkable.

The tissue of the uterus is dense, tough, elastic, grayish, difficult to dissect in its ordinary state; nevertheless, according to the researches which have been made during gestation, it is considered as muscular. *Weitbrecht* has pointed out small orbicular muscles, at the orifice of the fallopian tubes. *Sue*, remarks having observed on the surfaces, four muscular knots, which he considers as centres of contraction. *Madame Boivin*, has remarked in it, from the exterior to the interior, 1st, a muscular membrane extended from its fundus to the vaginal extremity of the neck; 2d, transversal fibres situated

on each side of the median line, between the two superior angles, on a level with which they send prolongations which form the fallopian tubes, the suspensory ligaments of the uterus, and the cords of the ovaries; 3d, continuing always under the first layer, we observe, on a level with the body, a layer, which from the orifice ascends in the form of a sheaf as far as the body, crossing the tranverse fibres; 4th, within, along the median line, on the anterior and posterior surfaces, some vertical fibres which are covered above, in order to form the orbicular fibres of *Weitbrecht;* 5th. Lastly, according to this lady, on the sides of the raphe anterior and posterior of the neck, arise some ramified regular folds, and some of which ascend on the body of the organ. Such is also the description of it given by *Charles Bell.* Lastly, Messrs. *Ribes* and *Chaussier* think that the superficial fibres of the neck are circular, that the deep seated fibres are longitudinal, and that they are continuous with those of the body. On its exterior, the uterus is covered by the peritonæum; within, by a mucous membrane the existence of which is denied by Messrs. *Chaussier*, *Ribes*, and Madam Boivin.

Vagina. This is a membranous vascular canal, from six to seven inches in length, destined to receive the penis; it extends from the neck of the uterus to its outward opening, where it terminates in the pudenda or vulva. On its internal surface we observe transversal ridges; its orifice, in the virgin, is partially closed, by a membrane called the *hymen*, of which we observe only some remains in women who have had intercourse with man, a layer of erectile tissue, a cellular membrane, and a constrictor muscle constitute the parietes of the vagina.

Lastly, the *vulva.* It presents, 1st. The *labia externa*, provided with an erectile tissue and sphincter; 2d. The labia interna, very sensitive and erectile; 3d, finally, the clitoris, an organ composed of a cavernous body, of a glans and prepuce, susceptible, like the penis, of erection. It is the seat of voluptuousness.

ARTICLE 3.

Organic and functional differences of the Sexes.

Thus far we have almost exclusively treated of the organism of man. It would be but proper, that before undertaking the functions which the union of the sexes requires, we should arrest our attention for a moment on the particular history of females.

1. *Stature.* The most exercised eye can detect but very few differences between the two sexes, during youth, but it is otherwise at the age of puberty. In man, muscles become more prominent, the chin is covered with beard; while in woman, her form becomes rounder, the breast enlarges, the face still preserves the sweetness of youth, the head remains smaller in proportion, and generally speaking the neck is longer, the chest narrower, the shoulders less prominent, larger arms, smaller hands, and the fingers more slender, have an enchanting elegance; a broader pelvis, shorter limbs, larger knees, inclining inwards, smaller feet; finally, the bony projections are always less marked; the whole is more slender and delicate; the cellular and adipose tissues are more abundant, the skin, whiter and finer to the touch, is only covered with a slight down,

whilst the hair being longer, becomes a new source of beauty.

2. *Nutrition.* The organs which concur to this function are always less developed in woman than in man, and this is the reason she consumes a smaller quantity of aliments than we, her hunger or appetite is more capricious, but easier to satisfy. Respiration is shorter but more frequent, circulation is more active, the pulse not so full; the secretions generally are less abundant, if we except that of fat.

3. *Sensations.* Women's brain is less developed than that of men, but their nerves are bigger and somewhat softer; they evidently exceed us in the delicacy of their sensations, and the acuteness of their senses. Behold the vivacity of their looks; their other senses are no less acute; hence an infinity of impressions which escape the notice of man, and which give them that benevolent, kind, tender, compassionate and devoted character; hence also, a too great number of ideas to be ripened by reflection, and consequently that mobility with which they are justly reproached; vainly they attempt to be constant, their constitution shows the fallacy; their great disposition to receive impressions necessarily causes them continually to change their determination, and produces in them a multitude of caprices for which they themselves can not account. From this continual and rapidly varied activity of the nervous system in women, it results, also, that they are unfit for close and serious studies; and that it is impossible for them to rise to the sublime height of the sciences; they have nothing profound or vast in their thoughts, but their mind is gentle and graceful, and their conversation lively

and full of agreeableness; so that they must excel in music, and in the art of delineating the movements of the human heart.

4. *Locomotion.* In woman the organs of movements are different from ours; the bones are not so long nor so big; their curvature is less appreciable, the muscles are smaller, so that she is not capable of much bodily effort; the crests of the ilia are wider apart, hence a considerable rotatory movement of the pelvis whilst walking, and to which, grace is ascribed.

5. *Expressions.* Sensibility being much greater in woman, her pathetic language must be very diversified and very expressive; her voice also must be very different from that of man, and this is owing to the apparatus of the voice being smaller; it is generally sweeter, more harmonious, and more touching.

6. *Sleep.* All the acts of woman seem to be stamped with a peculiar character, lightness. Sleep is, in her, less sound than in man, nor does it last so long.

7. Lastly, *Menstruation.* Man has nothing like it; it is a sanguineous exhalation, which occurs periodically during four or five days in every month, and which announces the fecundity of women. This menstrual evacuation, in our climate, occurs between the ages of thirteen and fifteen, they are more precocious in southern countries, and, on the contrary, later in northern latitudes.

Sometimes the menses appear suddenly without any previous sign; but most generally, they are preceded by vague pains, weight in the lumbar regions, a pricking sensation in the mammæ, an unpleasant itching in the genital parts. In some cases there

happens even more serious accidents; a violent fever is induced, the skin is red and hot, the young girl refers her pains particularly to the lumbar and hypogastric regions; finally, some drops of blood appear, and thus ends all this scene of pains.

The menses seldom assume a regular periodicity at the beginning of their appearance; it is only after several months have elapsed, that the menstrual flux takes up a regular character. In the course of life it is subject to some changes, either in the period of their recurrence, or in their duration, or in the quantity of blood which is evacuated, or, lastly, in the nature of the phenomena, which precede, accompany, or follow it.

Finally, there happens a time, in which woman has an entire cessation of the menses, and with it loses also the aptitude for generation; this occurs commonly at the age of forty-five or fifty in this country, (*France*) later in the northern latitudes, and sooner in warm southern climates. This period is very often marked by serious accidents, hence the designation of *critical age*.

Some physiologists wish to explain the periodicity of the menses by lunar influences, by an uterine fermentation, by a too profuse nourishment which produces an exuberance of sanguine fluid, by a determination of the soul. It is generally thought, that when women arrive at the age of puberty, their blood is in a sufficient quantity for two individuals, and it is by menstruation that they rid themselves of the superfluous blood, when they are not pregnant, or after lactation.

ARTICLE 4.

C. *Of Copulation.*

Copulation consists in the union of the genital organs of both sexes; it is the act in which voluptuousness is excited, and which entice us to reproduction.

Sensation which invites to coition. Nature, always mindful of her own works, has attached the allurement of pleasure to the fulfilment of the functions which insure individual existence; she has been no less provident for those which protect the perpetuation of the species. At the age of puberty a lively imperious sensation is felt, unknown till then, and which excites to copulation. This sensation, very distinct from all others, was referred to the genital organs by most physiologists; M. *Gall*, on the contrary, makes of it one of the affective faculties of the soul; it is, according to him, a cerebral phenomenon, which has its seat in the cerebellum.

Man, solicited by this sensation, has an *erection*, i. e. the penis is swollen, becomes stiff by a considerable afflux of blood in the cavernous bodies, the urethra and glans penis; from this moment, this body, which has acquired powerful strength by this active congestion, surmounts all the obstacles that the orifice of the vagina might present, and penetrates deeply into this organ, in directing its course towards the neck of the uterus; the very great degree of heat communicated by the parts of the woman, and the voluptuous friction, of which it is the seat, propagate its orgasm to the whole economy, and particularly to the organs of fecundation; the testicles are

drawn nearer the ring, and, pressed in their envelopes, increase their activity; the vesiculæ seminales contract, and dart the semen which they contain into the canal of the urethra, where it arrives, in conjunction with that which is directly derived from the testicles; by the synergic and convulsive action of the levator ani, the erector penis, the accellerator urinæ, and the canal itself, the semen is darted with a sensation of indescribable voluptuousness, which throws man into a state of convulsion, and which often forces him to cry out; the pleasure is more or less prolonged, but the penis relaxes immediately into its ordinary condition.

Woman does not remain passive in the act of coition; the sensation of desire determines an active congestion in all the erectile parts of the vulva and vagina, and the approach of man, particularly the introduction of the penis, that plunges her into a voluptuous orgasm, which gradually increases even to produce general convulsions, and which end in a greater or smaller excretion of vaginal mucus, to which succeeds a languor, which is also full of charms.

ARTICLE 5.

D. *Of Fecundation.*

We understand by this term, the mechanism of the formation of a new being, by the contact of the elements, furnished by the concurrence of both sexes.

As to man, it is obvious that the semen is the only fecundating liquor, as it is most abundantly proved by the experiments of *Spallanzani* in his artificial fecundations of frogs and dogs, and of *Ja-*

cobi, of fishes. These ingenious experiments have been repeated with ample success by Messrs. *Dumas* and *Prévost*, who also have remarked, as was advanced by *Spallanzani*, that the semen ought to be diluted in order to become fit for fecundation.

Some physiologists think that the semen deposited in the vulva-uterine canal, is absorbed to be carried on the ovary by the means of the circulation; others think that there arises a vapour from it (*aura seminales*,) which directly goes to this organ; but it is generally admitted that this liquor is darted into the uterus, and even that it is drawn into it by the aspiration of its orifice; *Ruysch* has found it in a young woman surprised in the act of adultery, and killed, during the act of copulation, by her busband.

The semen, when it has arrived in the matrix, according to *Dumas* and *Prévost*, and some other physiologists, fecundates in it the ovum, which is brought here from elsewhere; or, and this is the most general opinion, at the moment of the voluptuous orgasm, which accompany coition, the fallopian tube itself is in a kind of erection, during which, it forcibly carries its fimbriated body on the ovary, and brings to it the fecundating liquor; indeed, *Haller* has met with semen even in the fallopian tubes close to the ovary; and *De Graaf* and *Magendie* have found, some hours after copulation, the fimbriated body forcibly bound on this organ; abdominal gestation and that in the fallopian tubes, that *Nuck* produced at pleasure by tying this tube, give to this opinion a strong character of truth.

As to the part which the woman performs, is also evidently proved, that it is from the ovary that the part which she furnishes comes, for the accom-

plishment of fecundation. *Harvey* first advanced, that an ovum was detached from it, *De Graaf* demonstrates it by precise experiments; he considered it as composed of two membranes and of limpid liquor; *Haller*, and since, *Dumas* and *Prévost*, have performed new experiments on this subject; they have observed, after a fecundating coition, a vesicle developed on the ovary, to enlarge during five or six days, afterwards break, and an ovulum to escape from it through a small bleeding orifice, which leaves a yellowish spot behind; this small ovum, when examined with a magnifying glass, presents a *small cicatrix*, (*cicatricule*) or navel, similar to that of the seeds of plants.

In the moment in which the small ovum is detached, the fimbriated body seizes and transports it into its last destination, the *uterus*. *Bussière* has observed this small body partially engaged in the fallopian tube, as it was still adhering to the ovary.

In every thing we have remarked thus far, we have always been led by actual observation, and we have been able to follow nature in all the stages of her operations; but if we seek to penetrate into the causation of the first spring of vivification, observation abandons us at our first step, and we are left to ourselves, and must inevitably fall into the obscurities of hypotheses. We may refer all the theories which have been advanced to the two following:

1. *Epigenesis*. In this hypothesis, it is believed that the new individual is composed by the fusion of the materials furnished by both sexes, by the means of the power called *formation*. M. *Lamark* believes organized bodies to proceed from a spontaneous generation, which occurs under the influence

of a vivifying cause, appertaining probably to light and electricity; he adds, that every time that this cause meets with gelatinous matter, it produces living beings; that this is the manner in which the human embryo is formed, *which from this low degree of organization gradually rises to that which is proper to man.* *Hippocrates* admitted in both sexes a male semen, and a female substance, which, by means of heat, engendered new beings by a kind of animal crystalization. *Descartes* ascribes it to a movement of fermentation in both semen; *Pascal* observes that their combination is required by their chymical nature, the one being acid, and the other alkaline; *Buffon* admits living molecules, and he thinks that generation occurs by the combination of these *molecules*, which he calls *organic*, with a little *dead matter, &c.*

2. *Evolution.* In this other system, the germ is furnished by both sexes, and by a series of developments, it arrives to constitute at last a new individual. The physiologists who entertain this opinion, are divided into two sects.

1. Some, by the analogy of the oviparous animals, admit that the body, which is detached from the ovary, is an ovum, formed with an embryo, and with particular organs destined to its nutrition, and to its development; that this embryo contains the germ of a new individual, which only awaits favourable circumstances, dependent on fecundation, in order to develop itself. Among those who advocate the hypothesis of *the ovarists*, there are some, at the head of whom we find *Bonnet*, who presume that the eggs are contained the one within the other, in such a manner, as to be fecundated successively; that the first woman had contained, in one of her eggs, the

whole human race, and that, consequently, this race must one day cease to exist, because of the exhaustion of the reproducing ovuli. Others, more judicious, think that every woman produces her own eggs by a kind of secretion.

2. After the discovery of spermatic animalcules, most physiologists supposed them to be the rudiments of new individuals. *Andry* believed that they lodged themselves in one of the vesicles of the ovary, to draw from it its first nutritive elements, and that they afterwards returned into the cavity of the uterus. *Animalculism* was generally forgotten, when Messrs. *Dumas* and *Prévost*, by ingenious researches, have again revived this hypothesis, that the *spermatic animalcules* are the agents of fecundation; these experimenters, think that the ovulum is only a cellular sheath in which the organs are formed; and from the first rude lineaments of fœtus that they have observed, they conjecture, that the animalcules contain the rudiments of the nervous system of the new being. M. *Rolando*, who has adopted this hypothesis, observes likewise, that the ovulum furnishes also the rudiments of the cellulo-vascular system, and that the spermatic animalcules contain those of the nervous system.

Nevertheless, most modern physiologists, while applauding the efforts made by these ingenious experimenters, in order to penetrate into the secrets of conception, they confess that the science is too obscure, to give a satisfactory explanation on this phenomenon.

Whatever may be the cause, fecundation is irresistibly performed; volition has no power over it; we can not engender at pleasure different sexes, nor

have any influence on the number of children, nor on their physical qualities, or on their future morals.

ARTICLE 6.

Development of the Ovum in the Uterus.

Whatever may be the different hypotheses on the subject of fecundation, the fecundated ovulum contains the elements of a new being; its cicatrix presents an outer membrane called chorion (*champ opaque*), and an inner one called amnion (*champ transparent*); in the centre of the latter, we observe the rudiments of the nervous system: Such is the condition in which the human fecundated ovum proceeds to the uterus.

An impenetrable obscurity prevails on the first periods of the development of the organization of the fœtus; writers have not yet agreed in an incontestable manner as to the epoch at which the new being is clearly seen in the human ovulum: all that has been remarked on this point of physiology, is no better than hypothesis.

About three weeks after fecundation, the embryo appears under the form of a small worm, somewhat larger in its middle, free in the cavity of the ovum, or rather adherent to its internal membrane, by the part of the body which hereafter will correspond to the insertion of the umbilical cord. This small vermiform body, contained in its own membrane, (the *amnion*), exclusively belongs to the trunk; it already presents a small circle which is the rudiment of the sanguine system, and on which, is soon developed a small pulsating cavity, (*the heart*); soon after we remark, at the superior part of the trunk, a little projection, which is separated by a small ex-

cavation; this is the origin of the head, which soon acquires a considerable volume; at this time the spinal marrow becomes more and more evident, and the nerves expand.

Towards the sixth week, two small points announce the formation of the eyes, and a transversal fissure, that of the mouth; soon after, appear the lineaments of the superior extremities at first, and the inferior afterwards; the intestinal canal is situated perpendicularly, and before the spinal column, the anterior parietes of the abdomen forms a conoidal projection, which still adheres to the membranes of the ovum; this latter, as a whole, has an ovoidal form, about one inch and a half long, to one inch and two lines wide.

Some days after, the embryo is separated from the membranes of the ovum, the abdominal parietes seems to be elongated into a funnel form, in order to make the umbilical cord; at this period, before the inferior extremity of the spinal marrow, which is twisted into a tail, appears several openings, which are the rudiments of the anus and genital organs.

From the ninth to the tenth week, the mouth is formed by the occlusion of the lips, but its cavity still communicates freely with that of the nasal fossæ; the eye-lids cover the eyes, the auricular openings begin to appear, the hand to digitate, and the rachidian tail to disappear.

Towards the twelfth week, every part of the face is well defined, the sternum shuts up the anterior parietes of the thorax, the intestine, at first contained in the umbilical cord, recedes into the cavity of the abdomen, the skin begins to be organized, the embryo has grown to the size of five or six inches long.

From the fourth to the fifth month the parts become more and more proportionate and distinct; ossification makes some progress, the skin assumes some consistency, reddish fatty matter is deposited in the cellular tissue.

Finally, in proportion as it approaches more the period of birth, the skin covers itself with a delicate down; the follicles very much developed, secrete a white oily humour, the hair grows, the parts become firm and round, and assume the proportion which charaterize our species.

The embryo does not float freely in the cavity of the uterus; it is inclosed in special membranes, which attach it in the cavity of this organ, and serve to its nutrition and growth, by establishing between it and the mother functional relations; it is therefore necessary to examine these accessory membranes before we give the history of the phenomena of the life of the fœtus.

ARTICLE 7.

Of the membranes of the Fœtus.

At the time of coition, the uterus experiences the orgasm of the other sexual parts, and if fecundation occurs, it continues to be turgid, the uterine parietes augment gradually in thickness, soften, and become more vascular; in the mean time the cavity dilates, and is filled with a sero-albuminous matter, which is organized into a membranous sac, which the ovum pushes forward, when it enters into the matrix through the internal orifice of the fallopian tubes; this membrane, called *decidua* by *Hunter*, *epechorion* by *Chaussier*, is doubled on itself, over the whole surface of the ovum, which, however,

no more contains it within its cavity than the pleura does the lungs, as was demonstrated by Messrs. *Moreau*, *Velpeau*, and *Breschet*. At first, thick, soft, pulpy, not unlike the surface of the crescmentum of the blood, the decidua becomes thinner, the more the period of labour approaches; it loses, at the same time, its organization, and seems to become almost inorganic.

This membrane, as we have just seen, does not belong, properly speaking, to the ovum; it only serves to fix it in the uterine cavity during the first months of gestation, whilst those of which we are going to treat, properly appertain to the embryo.

2. *Chorion.* This is the most external membrane of the human ovum. It is thin, transparent, its external surface is covered with numerous vascular *villosities* which unite it to the decidua, except in the place where this latter has been reflected on itself by the entering of the ovum, and where these villosities must afterwards, by being developed, constitute the *placenta;* its internal surface, likewise villous, corresponds to the membrane of the amnion, from which it is, in the first weeks of gestation, separated by a certain quantity of serosity. M. *Velpeau* has perfectly demonstrated, that this membrane is composed of one single leavelet or lamina, instead of two, as was generally admitted before; he has observed it distinctly, even as early as the twelfth day of conception.

3. *Amnion.* It is the first membrane which is developed; it immediately surrounds the embryo, as we have already observed. It is thin, white and transparent, and is separated from the chorion during the two or three first months of pregnancy, by a fluid called *false waters of the amnion*, after-

wards, it intimately adheres to this membrane by cellular filaments, which have been believed to be vascular; it lines the fœtal surface of the placenta, accompanies the umbilical cord with which it is closely connected; hence it is continuous with the epidermis of the embryo, as was demonstrated by M. Velpeau. It is not positively known if this membrane receives its vessels from the mother or from the fœtus. M. *Chaussier* injected them from the side of the mother; *Monro*, by throwing the injection through the fœtus, so that it is probable that it receives some from both.

The cavity of this membrane contains a fluid named *liquor amnii*, and which abounds the more as the term of utero-gestation advances. This humour is at first clear and pretty transparent; later it becomes viscous, and contains more or less caseous flakes; its source has not been properly ascertained; some believe it furnished by the mother, others by the fœtus, and consistent with the latter hypotheses some physiologists have considered it as the result of the cutaneous and urinary secretions.

M. Vauquelin has analysed the liquor amnii; this learned and eminent chemist has found it to contain water, albumen, soda, hydrochlorate of soda, lime, and phosphate of lime. M. *Berzelius*, has detected in it fluoric acid; *Chècle*, oxygen; and *Lassaigne*, atmospheric air.

4. *Placenta.* It is a round or oblong vascular and spongy mass, thicker at its centre than at its circumference, having from six to nine inches in diameter; developed at a point of the exterior surface of the chorion, it adheres on one side to the uterus, and communicates on the other with the fœtus, through a prolongation named *umbilical cord.*

According to M. *Velpeau*, this organ is formed by the development of the gangliform granulations which are remarked on the part of the external surface of the chorion, where the *decidua* is wanting, and which is in close contact with the matrix; thus we find it ordinarily situated in this organ close to the fallopian tubes. M. Velpeau thinks that these granulations contain the rudiments of the vessels of the placenta.

The uterine surface of the placenta is covered by a very thin vascular and cellular membrane; its fœtal side presents, in its centre, the insertion of the umbilical cord; it is lined inside and outside by the chorion and amnion. The parts which enter into the composition of the placenta, are, 1st, arterial and venous vessels, proceeding from the uterus and ramifying in the corresponding face of this organ; 2dly, arteries and veins, which proceed from the fœtus, and are ramified on the outer surface without communicating with the preceding. 3dly, White filaments, considered to be obliterated vessels. 4thly, A cellular web; 5thly, lymphatic vessels; 6thly, lastly, according to Messrs. *Chaussier* and *Ribes*, some nerves proceeding from the great sympathetic of the fœtus.

5. *Umbilical cord.* This is a vascular cord, which establishes a communication between the placenta and the fœtus; in the beginning of gestation, the embryo adheres closely to the amnion, by the anterior parietes of its belly; it is only towards the sixth week that this cord is developed. At first very short and resembling an hour glass, it contains the intestinal canal; afterwards its length increases rapidly, and narrows as it approaches the abdomen; this cord consists, 1st, of the umbilical vein, which pro-

ceeds from the vena cava inferior, and is ramified in the placenta after having communicated in the liver with the vena portarum; 2dly, of two umbilical arteries, which are continuations of the primitive iliacs; they likewise proceed to and join the placenta; 3dly, of the urachus; 4thly, of the omphalous and mesenteric vessels; 5thly, of nervous filaments of the great sympathetic; 6thly, finally, of a cellulo-gelatinous tissue and of its envelopes.

6. *Umbilical vesicle, (Vesicula umbilicalis.)* At first denied by some anatomists, it is now pretty generally admitted by all. This is a small bag of a dense and granular texture, filled with yellowish humour, which is situated below the anterior part of the embryo, and which is considered as analogous to the *vitelline* sac in birds. In fact, this vesicle receives, like the latter, omphalo-mesenteric vessels, and it is from it that the intestinal canal proceeds, as *Wolf, Hunter, Oken, Bojanus, Meckel,* &c. have demonstrated. Towards the third month the vesicula umbilicalis disappears.

7. *Allantoid.* Opinions are as yet divided with respect to the existence of the allantoid in the human fœtus. The following authors admit of it: *Nudham, De Graaf, Haller, Cuvier, Meckel,* &c. This organ is a small membranous reservoir placed tween the chorion and amnion, or, according to M. Velpeau, exteriorly of the chorion, and which communicates with the bladder through a tube called *urachus;* it is filled with a limpid fluid, which has been supposed to be the urine of the fœtus, or, with some more likelihood, to be alimentary matter kept in reserve.

ARTICLE 8.

Physiology of the Fœtus.

INTRA UTERINE LIFE.

1. *Nutrition.* M. *Chaussier* thinks that the sero-almuminous substance, which fills the uterus at the time of fecundation, is intended for the nutrition of the embryo during the first period of its development; but we have already remarked, on Messrs. *Moreau's* and *Velpeau's* authority, that this substance was, before the ovum enters into the cavity of the uterus, organized and converted into a membrane, the *decidua*. Afterwards, authors have also considered the fluid contained in the umbilical vesicle as being nutritive, arguing from the analogy existing between it and the yolk of the eggs of birds, which in its turn has been compared to the *cotyledon* of vegetables: this ingenious comparison appears highly probable. In fact, in the same manner as we see the *cotyledons* to fade and drop away, when the radicles of the new plant has reached a certain degree of growth, thus, we also observe the yolk of the egg to be absorbed for the development of the new being; in the same manner also we remark the umbilical vesicle, of a very considerable size in the human ovum, disappear in the same degree as the placenta is developed; in this hypotheses, it is supposed that this pouch pours the nutritive substance into the intestinal canal, where it is digested; but it is more likely, that it should be immediately conveyed into the vascular system by the omphalo-mesenteric vessels. The greater num-

ber of physiologists ascribe the nutritions of the fœtus to the liquor amnii; some, as *Osiander*, *Buffon*, *Vandenbosch*, have it absorbed through the skin; others, as *Boerhaave*, *Haller*, &c., believe that it passes through the mouth into the digestive canal; finally, others again, such as *Rœderer*, *Winslow*, &c., suppose it to penetrate through the aerian passages of respiration; but all these opinions are speculations altogether hypothetical, and it is wise to remain at least, in doubt, with respect to the nutritive action of this humour. Some physiologists are of opinion, that the blood is directly conveyed from the mother to the fœtus, through the villosities, which connect the uterus with the *mambrana decidua*, and this latter with the chorion. In order to prove this hypothesis, it would be necessary first to demonstrate, that these villosities are of a vascular nature. M. *Meckel* considers also the gelatinous substance contained in the umbilical cord, as being also nutritive. Lastly, the placenta is very generally supposed to be a source of nutritive matter; its increase, which corresponds with the disappearance of the umbilical vesicle, tends to prove that they are the only sources, or at least, the two principal organs for the nutrition of the fœtus; that the vesicle provides the necessary materials for its growth, during the two or three first months, and that the placenta supplies it till the moment of birth. The ancients supposed that the blood passed directly from the mother to the fœtus, by means of the placental vessels; but injections have since proved, that there exists no such direct communication. It is now generally admitted, that the uterine vessels deposit on the parietal surface of the placenta, a fluid,

which is afterwards absorbed by very minute vessels of the umbilical cord.

Now that we are acquainted with the principal sources from which the fœtus draws the materials proper to its growth, let us examine how these substances are converted into its own body. It is very certain, that the embryo elaborates its own blood from the humour of the umbilical vesicle, in the same manner as birds borrow from their *vitellus;* but by what mechanism is this conversion operated? We only can answer this question by conjectures more or less specious; again, what is the kind of fluid conveyed from the uterus to the placenta? what change does the latter organ produce on it? and in what state does it reach the fœtus? This part of intra-uterine physiology is involved in the greatest obscurity. M. *Geoffroy Saint-Hillaire,* pretends that a very great part of the blood which is derived from the mother, is distributed to the liver for the secretion of a peculiar bile, which poured into the intestine, excites an abundant mucous secretion, and that this mucus is constantly digested and absorbed by the chyliferous vessels, and afterwards circulated in the vascular system. According to this physiologist, the *meconium* is an evident proof of fœtal digestion.

According to some physiologists, the placenta fulfils the office of a respiratory organ, that is to say, the blood is sent into it at each pulsation to be vivified within its texture: Such is the opinion entertained by Messrs. *Lobstein, Schregar, Béclard,* and especially *Meckel,* who ascribe no other use to this organ.

The movement of the blood in the fœtus, varies at the different periods of its formation. 1st, In the

earliest stage there exists only the ramifications and the trunk of the omphalo-mesenteric vein, the parietes of which are not as yet distinct from the other parts of the embryo; properly speaking, there is as yet no circulation; 2dly. Subsequently, this vein terminates in the vena portarum, which produces the superior part of the heart; from this latter arises the aorta, which is extended inferiorly to form the *vitellary* artery; from this moment a simple circulation is established, the blood proceeds from the umbilical vesicle to the heart, and hence is distributed throughout the body, and is returned by the omphalo-mesenteric artery; 3dly, after this period, the placenta is developed, together with the two umbilical arteries, and the umbilical vein, which vein unites in the liver with the vena portarum; at this time circulation becomes more complicated; 4thly, and lastly, the vascular system gradually improves, and circulation becomes double: we have elsewhere indicated what characters it presents at the time of birth.

The blood, distributed to all parts, develops, and in some measure, may be said to *secrete* the organ, and contributes to their ultimate increase, and to their perfection; at first very simple, these organs gradually pass to more complicated degrees of texture, passing, as it were, through the various degrees of organization presented by the animal scale; it seems that man gradually rises, during his uterine life, from a simple to a more complex organization, until he reaches that which belongs to his species.

Finally, to terminate the history of the fœtus, there remains only for us to add, that even at this early period, several secretions are observed, such as the cutaneous, serous, synovial, adipose, and

those of bile and urine. Some physiologists consider the *meconium* as being the result of a peculiar secretion.

With respect to the functions of relation, and of reproduction, the former are very doubtful, and the latter are next to nothing.

ARTICLE 9.

D. *Of Gestation.*

We understand by gestation, the sojourn made by the embryo in the uterus, from the moment of conception till the period of birth.

The ovum, fixed in the uterine cavity, gradually grows during the nine solar months, which is the term of gestation; consequently the uterus increases in the same proportion. During the two or three first months, the effect is not much appreciable externally, the body of the organ assumes a globular form, and descends into the pelvis; but it soon occupies a larger space, it compresses the abdominal viscera, it gradually ascends into the hypogastrium; at the same time, its neck recedes from the orifice of the vagina; lastly, during the two last months it takes up all the umbilical, and even a great part of the epigastric regions; at this time the neck softens and dilates, and is ultimately entirely obliterated. The uterus at this time presents an ovoidal form, the vagina is lengthened, its mucous secretion becomes more abundant, the ovaries are applied on the sides of the matrix, the abdominal parietes experience a considerable extension, the neighbouring parts are compressed, &c., &c.; in the meanwhile the structure of the uterus changes, and evidently becomes muscular, as we have already remarked,

and the menses are suspended. Some physiologists ascribe the dilatation of this organ, to the growth of the embryo, others are of opinion, that it is owing to a peculiar mode of nutrition.

ARTICLE 10.

E. *Of Labour. (Accouchement.)*

It is, properly speaking, the act of bringing forth, or excretion of the fœtus from the womb of the mother; it is a function as natural as defecation, as long, however, as labour is natural. We can not treat here of such cases as demand the assistance of the physician. Birth occurs at a fixed period.

1. *Causes.* It was supposed formerly, that labour was induced by the weight of the fœtus, or by the efforts that it makes to disengage itself from the uterus. Buffon accounted that it was owing to the separation of the placenta from the uterus. Now it is believed that it is induced, first, by the increased irritability of the uterus and by its mode of dilatation; afterwards, to the changes which supervene in the circulation of the placenta. Indeed, as we draw nearer the time of parturition, a part of its vessels are obliterated, and as a natural consequence the blood flows to the uterus and solicits its contractions.

2. *Conditions required for delivery.* In order that the expulsion of the fœtus may be natural and easy, it is necessary, first, that the woman should have a good conformation; that the excretory canal should present dimensions sufficiently large for the volume of the child; that the neck of the uterus should become thin and elastic; that the external genital parts should be sufficiently lubricated. On

the other hand, the well-formed fœtus, must present one of the extremities of the ovoid form which it possesses in the uterus; the most favourable and the most common circumstance is, when the head enters the pelvis in such a direction, that the posterior fontanelle corresponds with the left acetabulum, and the anterior fontanelle to the right sacro-iliac symphysis; in this position, the posterior fontanelle may easily pass the arch of the pubis, and the back presents a wide surface for the abdominal muscles to act upon.

3. *Mechanism.* At first, a peculiar internal sensation announces that birth is about to occur; it is not one of those agreeable sensations which, when gratified, assumes a pleasurable character; but it is attended with pains, which at first indescribable, and occurring at long intervals, become the more intense and frequent, the more the moment of birth approaches.

In labour, several periods are distinguished. A. *Petit* and *Desarmeaux* admit of three, M. *Chaussier* five: we shall reduce them to four.

Preparation for delivery. The head of the fœtus, embraced by the neck of the uterus, descends into the cavity of the pelvis, so that the abdomen relaxes, and the mother feels relieved; the symphisis of the pelvis slightly yields,* the vagina is lubricated and dilated, the neck of the uterus is obliterated, and is opened in consequence of the slight contractions of this organ.

Dilatation of the neck. The contractions gra-

* Dr. *Dewees*, in his system of midwifery, adduces four principal reasons against the opinion, that this relaxation of the symphysis of the pelvis, is a *natural* or *physiological* provision: indeed, the whole tenor of his reasoning tend to prove the contrary. TRANS.

dually become more and more powerful and painful, and assume an intermittent type; they are effected in the longitudinal direction, i. e. from the body to the neck, so that they tend to dilate the latter; they continually succeed each other, and whilst they last the head of the fœtus is felt passing the uterine orifice, which, by the distension which it experiences, considerably adds to the intensity of the pains. In the meanwhile, the membranes of the fœtus separate from the circumference of the placenta to the opening of the neck, in which they protrude in the shape of a *sac;* they rupture at a certain period, and the *waters* flow out, often mixed with a little blood. Finally, the head of the fœtus, closely applied to the orifice which it has to pass, induces a suitable degree of dilatation of the parts.

Expulsion of the Fœtus. When the os uteri has been sufficiently dilated so as to admit of the passage of the fœtus, both the contractions and uterine pains increase; finally, the head, after several successive efforts, crosses the neck of the uterus, and descends into the vagina; in this position, the chin is flexed over the chest, the posterior fontanelle presses against the left acetabulum, and the face looks above in the concavity of the sacrum; from this moment the contractions of the abdominal muscles are joined with that of the uterus, and the head progresses forward, experiencing a slight rotatory motion, which carries the occiput under the arch of the pubis; the coccyx is depressed by the face; the perineum becomes thinner, the nymphæ are obliterated, and the labia externa forcibly distended, are widely opened; the pelvis is immovably fixed by the lumbar muscles and by those of the inferior extremities; the mother strongly grasps every thing

that comes within her reach; finally, contractions occur in such rapid succession, that they become almost continual; the head is disengaged from under the pubis, and by a last and painful effort, it passes the vulva and successively presents, after having turned on the pubis, the forehead, the nose, the mouth, and chin, the remaining part of the body follows without difficulty; from this moment, the child breathes and possesses life independently of the mother.

Delivery. Soon after the expulsion of the fœtus, there occur new pains, which cause the separation of the placenta, and the expulsion of the secondary membranes, (*sécondines.*) Should any part of the decidua be left behind, it is afterwards discharged together with the lochiæ; finally, the woman being completely delivered, she enjoys a delicious rest, which, conjointly with the pleasure of being a mother, compensates her for the excruciating suffering she has just endured.

ARTICLE 11.

F. *Of Lactation.*

No sooner does the child come into the world than it enjoys a free and isolated life; but it is yet too feeble to draw for itself, from the external world, the materials needful to its growth; moreover, its digestive apparatus is yet too imperfect, and would not be sufficiently strong to bear ordinary food; it is also the mother who is entrusted with the important care of insuring its existence during the first months after birth. Such is the object of lactation.

1. *Organs.* At the time of puberty, the lateral parts of the chest of the female, present two hemispherical or conical projections, hard and firm in

the virgin, softer in women who have borne children; they are covered with a softer and finer skin, than any other part of the body; these are the *breasts.* In their centre we observe a circular and rose coloured areola, provided with follicles, which exhale an unctuous fluid very well calculated to protect the nipple from the action of the saliva of the child. In their centre rises the *nipple,* a conoidal erectile eminence, on the surface of which, the lactiferous tubes terminate.

The part most important for our consideration, is the mammary gland, a kind of uneven convex body, which results from the union of glandular lobes clustering together, and united by a dense cellular tissue; these lobes themselves are formed by lobules, which by close examination may be themselves traced to miliary granulations; these latter receive the arterial ramifications which supply them with the materials of secretion, and give birth to the lactiferous vessels or tubes, which, flexuous and semi-transparent at first, are afterwards united into larger and larger trunks, directing their course towards the centre of the gland, without communicating from one lobe to another; afterwards they form sinuses of different forms and sizes, which, at last, produce small excretory ducts traversing the centre of the nipple, and opening on its surface.

2. *Functions.* During pregnancy the breasts are swelled, and sometimes secrete a serous fluid. During the two first days immediately after birth, the secretion augments in activity, but, as yet, produces only a sweet, serous, and slightly purgative fluid, called colostrum. Finally, the third or fourth day, the mammæ are seen to swell, become hard, warm, painful, and the secretion of milk begins; the suc-

tion of the child, as well as his hands which he ordinarily passes over the breast, determines in this organ a voluptuous orgasm, which keeps up the activity of the secretion.

The mechanism of this function is, however, the same as that of all the glandular secretions. Nevertheless, M. *Richerand*, taking into consideration the quantity of lymphatic vessels observed in the mammæ, and which are dilated during lactation, thinks that milk proceeds from lymph; other physiologists assert that it is derived from chyle: M. *Girard*, maintains that it comes from the uterus through imaginary vessels that were never seen. As to the excretion, it commonly occurs only at the time of suction; during the intervals the milk is accumulated in the vessels and in the sinuses, the mammæ swell, and soon experience the want of being emptied or sucked; small membranous bands, situated at the orifice of the lactiferous vessels, prevent the spontaneous effusion of milk.

3. *Milk* is a mild fluid, slightly sweet, of an opaque white colour, of an odour *sui generis*. M. *Berzelius*, distinguishes in it the cream and milk. According to him cream is composed of butter, of cheese, and of serum; this latter contains some sugar of milk, and different salts. *Milk* yields much water, a small quantity of cheese, sugar of milk, muriate, phosphate, and acetate of potass, phosphate of lime, lactic acid, and tartrate of iron.

After twelve or eighteen months this secretion dries up, and suckling terminates with the wonderful act of reproduction.

APPENDIX.

CHAPTER I.

OF AGES.

The name of *age*, has been given to the various modifications that man and all the other organized living beings present in their organization, and their phenomena, from the moment of birth to that of their natural death. These organic and functional changes gradually happen, and coincide with the succession of years; insensibly from day to day, they at last produce an impression on our organs, which may serve as data for the *physiological physician*, and which for him divide the course of life, into distinct periods, which he is able to appreciate without further references.

The division of *ages* varies according to physiologists; 1st, some considering the whole economy, and particularly the nutritive functions, admit of three: *the age of increase, the stationary, and that of decrease;* but, first, does there exist a stationary state or age? and in the second place, can we ascertain the precise moment at which one of these ages ceases, and the other begins? 2dly, other authors,

taking only into consideration the function of reproduction, propose also three ages; according as this faculty of reproduction does not yet exist, or may be accomplished, or has ceased to exist. 3dly. Finally, *Hallé* divides the ages into five principal ones, namely: the *first infancy*, the *second infancy* or *boyhood*, *adolescence* or *youth*, *virility*, and *old age*. We shall briefly examine the anatomical and physiological peculiarities which belong to each of these periods of life.

ARTICLE 1.

Of first Infancy.

This age is confined between the periods of birth till seven years old, the time at which the second dentition occurs; this is the most delicate and tender age, and which requires, consequently, most attention; and indeed, the mother, by an internal peculiar feeling, seems to sacrifice her personal gratifications to the pleasure of bestowing in the most prodigal manner, on the sweet pledge of all her affections and future hopes, the most tender and heartfelt cares.

The changes remarked in the organization at the moment of birth, characterize a new life; the lungs, which have been till now passive in the animal economy, begin to act, are filled with air by alternate motions of inspiration, and expiration, which will never end till the death of the individual. From this new function results the conversion of venous into arterial blood. Moreover, the *foramen ovale*, or of *Botal*, and the canalis venosus, and arteriosus are obliterated, as well as the umbilical vein and arteries; the *eustachian* valve gradually

disappears, the pulmonary arteries are considerably developed, and from this time circulation assumes a new character, that it is to retain throughout life, and the venous blood is forever isolated from the arterial. Lastly, at this time the functions of relation begin; as soon as the new being is born, he experiences painful sensation from the contact of the atmospheric air, and from the surrounding bodies; he utters cries, he agitates his body and little limbs, and thus proclaims his *civil rights;* from this moment his life is composed of all the already described functions; the umbilical cord dries up, falls, and leaves behind an indelible cicatrix (*navel*)*;* the body grows, new internal sensations announce his wants; materials are no longer brought to him already prepared for nutrition; the child clings to the breast of the mother, who provides for him an aliment appropriated to the delicate state of his digestive apparatus, but which requires his action, and prepares him to receive hereafter more solid substances, and more refractory to digestion; all the parts assume a more regular proportion, with the exception of the head, which still remains disproportionately voluminous, the face puffed up, and the belly too large; secretions are very active, ossification continues, the epiphysis are gradually developed; the senses of hearing and sight are only brought to perform their respective functions towards the fifth or sixth week.

At first, the child manifests no moral faculty, but he soon learns to know and to love his mother, to experience sensations, and to make his desires and will manifest.

As to station and progression, these faculties are only gradually developed; the same thing occurs with respect to the phenomena of expression, which from

the beginning are confined to gestures. Sleep is at first of long duration, it diminishes by degrees, until the duration of sleep is much shorter than that of watchfulness.

But the organization of the child will soon undergo a new revolution; it is especially in the digestive apparatus that it will occur; in fact the milk of the mother soon becomes insufficient for his nutrition. This function requires more solid aliments, then the teeth begin to appear, the salivary organs are developed, and mastication is established. The cutting of teeth, *(first dentition)* begins in the inferior jaw; afterwards it happens in the superior, and they successively appear in the following manner: the middle and lateral incisors; next appear the small molars and canine teeth, then, finally, the second molary successively appear, from the eighth month to the second year, the appearance of teeth sufficiently prove that the mode of alimentation of the child must be changed, that nutrition and growth must now depend upon more nutritive and substantial materials; moreover, the child, whose wants of food are urgent and frequent, craves the aliments of the adult, while at the same time the organic functions become more powerful and more active, and the general growth continually increases, and the body assumes a form of consistency.

It is during the first period of life that the child acquires an amazing degree of knowledge; his senses by degrees unfold to him the exterior world, and teach him how to act on the surrounding bodies, his intellect is constantly active; thus we remark, at this time, the anterior part of the brain acquires a very considerable degree of development. But if at this age the mind is remarkable for its activity

and aptitude, we must also observe that he is extremely absent, and lacks reflection, and that the circle of his ideas would be extended without order and much profit, if education did not lend its aid in order to give to them a useful impulse by successively subjecting them to the different actions of the mind, to *comparison*, *reflection*, *reasoning*, *judgment*, &c. Man is the more easy of being modified in his first infancy, since his organs have not as yet contracted habits, that they have received transitory impressions only, and that they await, in some measure, in a favourable condition, the impulse of a director.

ARTICLE 2.

Second Infancy.

This second age begins at the time of the second dentition, which commonly begins at the seventh year until the first sign of puberty, *i. e.* until the fifteenth year. This age is characterized by the general development of the body, the progress of which appears somewhat retarded by the second dentition and the beginning of the action of the genital organs.

The loosening and shedding of the infantine teeth warn us a new change is going to occur in the apparatus of mastication; the germs of the second dentition are developed and ossify, afterwards their appearance happens from the seventh to the eighth year, and is continued nearly in the same manner and order, as in the dentition in the first infancy; the alveolar processes enlarge gradually to make room for the second teeth, and the two larger molar teeth which did not exist in the former dentition; at the same

time the features of the face expand and assume a new physiognomy.

At this age the organic functions preserve all their energy, the stature increases considerably, but the body commonly loses flesh, (*embonpoint*,) the senses are most active, the intellectual faculties are more powerful, and can take a wider scope, sentiments of morality begin to be developed and which are to serve as guides in the future social life, by instructing in the duties that each individual has to perform; the phenomena of expression presents a vivacity which reveals how easily and how deeply impressions are caused at this period, and how very great the energy of the mind is. Finally, towards the close of this period, there occur in the genital organs changes which are the forerunners of another revolution in the constitution.

ARTICLE 3.

Of Adolescence.

During this third period of life, which is characterized by puberty, and which, in our climate, (*France*) extends from the age of fifteen to twenty five, in men, and from fifteen to twenty-one in females, the body acquires its full growth and complete organization; the distinction of the sexes is now very evident, and the genital organs have become capable of generation.

The two sexes, which previously were almost blended by their physical attributes, are now going to assume their distinctive characteristic. Man presents a slender and tall stature, his complexion becomes darker, his skin loses its former fine texture, and is covered with hair, especially about the

genital parts, in the axilla, and over the anterior part of the chest; in the meanwhile the beard grows, the muscles become more prominent, the splanchnic cavities, as well as the organic apparatus, acquire due proportions to the other parts of the body; finally, the sexual parts increase in size, the penis lengthens and the testicles enlarge.

In woman, on the contrary, the skin retains the softness, delicacy, and beauty of youth, it even becomes fairer; embonpoint augments, which moulds every limb into grace and beauty; her cheeks become more animated, her chest is more capacious, the mammæ swell, the hips and pelvis widen; finally, the genital organs are completely developed and are covered with hair.

In both sexes the thymus gland and the capsulæ renales are absorbed, ossification is completed, the larynx assumes all at once a considerable increase, the glottis lengthens and widens, as it was evidently demonstrated by Professor *Richerand;* finally, the maxillary, frontal, and spheroidal sinuses are developed.

Such important modifications in the organization, must necessarily produce also like changes in the functions; in fact, they are at this time in their utmost development; digestion is quick and easy, respiration is deep and soft, the blood is sent into every part of the body with energy, every thing announces the greatest degree of vitality in the organs; the follicular, cutaneous and genital excretions become very odorous; the benzoic acid of the urine is now replaced by urea.

At this period, sensations have acquired their utmost degree of delicacy, perceptions are clear and rapid; but ideas succeed each other with too much rapi-

dity to allow of being matured, decision or judgment anticipates reflection and reasoning, and its great activity often leads into error; this period is also that in which imagination begins its most brilliant career, and its ardour is still increased by the exalted desires which are soon to appear, and to impress a new character to the whole organization. At first, undecided and without an object, the desires of which we wish to speak, impress momentarily a character of languor and indecision to movements, determinations, and to all the organic functions; the mind soon becomes dissatisfied, melancholy; but the desires soon become very expressive and produce the most universal passion—*love*. This new want, proclaimed in man by audacity and violence, in woman by modesty, coquetry, and the desire of pleasing, coincides with the state of excitement of the organs of copulation, which are now endowed with an exquisite sensibility, and under the slightest stimulating cause to enter frequently into a state of erection; from this moment, the secretion of semen in man, and the menstrual discharges in females occur, and plainly proclaim that the organs of reproduction have attained their state of maturity to fulfil their office. It is at this period that the disturbance and languor of the functions disappear, and these latter receive an additional degree of energy, from the last development and increase of activity of the genital organs.

ARTICLE 4.

Of Virility or Manhood.

During the adult period of life, which extends for man from the twenty-fifth to the sixtieth year

of his age, and from twenty-one to fifty in females, the body still grows, the whole organization is perfected, and he enjoys the faculty of exercising with impunity the organs which excite us to copulation, the functions are in their utmost development, and are found in the condition we have already described whilst giving their history. At this period, every individual assumes a peculiar physiognomy; constitutions become strongly marked, and the body yields to the power of habit; every part has attained to a full degree of strength and of condensation: thus do we see the organs more voluminous and more resisting; they have reached their maximum of power, and endure fatigues for a longer time; the functions, without having lost the least part of their delicacy, have gained in vigour and extent; this is also very remarkable in the functions of the intellectual acts, which are capable of a more continued exertion. During this period, man unites to the most beautiful qualities of the heart, all the mental powers of mature age; love is a powerful incentive to all his actions, the charm of the most lively pleasure attracts him towards the partner who shares his desires and his feelings, and entices him to contract the sacred ties of matrimony.

But love is soon exhausted and yields to the desire of glory, riches, and honours; the want of connection between the sexes becomes every day less imperious, and we soon witness with sorrow and regret, the little frequency of erections, the flaccidity of the penis and testes, the softness of the breasts and nipples, the lengthening of the libia externa and nymphæ, which become flabby and pendulous, proclaim the approaching decay of virility; in the meanwhile, the appetite diminishes, the teeth begin

to decay and fall, to be never replaced; digestion becomes languid, and all the organic functions lose a part of their activity; sensations have lost their nicety, impressions become less vivid, and the mind slower in its operations, with the exception of judgment, which augments in the same proportion as the number of years; finally, the hair turns gray, the seminal secretion decreases, menstrual discharges become irregular and at last cease entirely. This period is by man spent without incurring any danger, is frequently fatal to females, and more or less endangers their life; and hence, has been called the *critical age.*

ARTICLE 5.

Of old age.

Old age, the last stage of life, is characterized by the total obliteration of the generative faculty, by the general decrease of the body, the progressive decay of all the organs, and also of that of the physical and moral powers.

In proportion as man gradually advances in this last stage, his body is curved, his skin becomes wrinkled, thin, dry and harsh; the cheeks are sunk in, as well as the eyes; the nose and chin become prominent, because of the absorption of fat, and drawn near each other by the loss of the teeth; the appetite gradually decreasing, sometimes disappears completely; digestion is slow and laborious; the large intestine, affected with atony, is frequently distended with dry and hardened fæces, and defecation becoming so difficult to be induced, that the attention of the old man is constantly engaged with

its accomplishment; the parenchyma of the lungs is altered, it is less vascular, the bronchiæ are often ossified and dilated; respiration is slower, panting is soon produced by the least exercise, the cavities of the heart either contract or dilate, their parietes are often affected with hypertrophy; the arteries are ossified and the veins dilated, circulation has lost its energy, the pulse is slow, irregular, intermittent; the blood with difficulty ascends against its own weight, and becomes stagnant in the most declining parts; secretions diminish in quantity, and the reservoirs free themselves slowly and with some difficulty of their contents.

The description, of the disturbances and deteriorations which occur in the functions of relation, is no less afflicting; the senses lose their exquisite delicacy, are blunted, and even end by being obliterated; the skin of the hand harsh and dry, imparts only deceiving impressions; the humours of the eyes soften and lose their power of refraction, or becomes thick and opaque; the changes which occur in the ear, not easy to appreciate, are nevertheless demonstrated by the difficulty of hearing, which is often owing to a mass of hardened cerumen in the meatus auditorius externus; the brain is softer, the gray substance paler; the membranes are often thickened, and present parts either cartilaginous or ossified, circulation is slower, and the blood stagnates in the over-extended vessels; the nerves are tough and smaller; perceptions are dull, memory is lost, attention is no longer fixed by external objects, but is entirely occupied with his own animal wants; the imagination is chilled; finally, judgment itself abandons the old man, and plunges him into a state of second infancy.

The qualities of the heart are less fugitive than those of the mind, and if some vanish in the same degree as decrepitude advances, there are some which seem to survive the general deterioration of the organs. Friendship, for instance, loses, it is true, much of its warmth, but it still remains genuine and sincere; the love of offspring, the feelings of gratitude, and the reverence inspired by our *Maker*, are never extinguished but with life itself.

With respect to motions, in old men, they become slow, and soon their performance is altogether impossible; the bones are large, their tissue hard and compact, but their cavities are much dilated; they weigh less than those of the adult, their articulations are stiff, the muscles flabby, small and pale; finally, the phenomena of expression soon participate in the general decrepitude, physiognomy gradually loses all its expression; the voice becomes hoarse, tremulous, and by degrees disappears.

The sexual organs become very flaccid; from this moment their action is impossible, and the wise man will submit to the general laws of nature; but if mistaking for wants the illusion of his imagination, or if, attempting to induce illusory desires by shameful means, the old man seeks to awake in the arms of love past enjoyments, he may probably meet, in a trial which exceeds his powers, with a severe punishment for his erotic delirium.

Such is the abridged sketch of the most important periods that man presents in the different stages of life; we have remarked in his organization and his functions, changes and continual modifications, making during life distinct periods—*the ages;* we have as much as possible referred them to lunar periods; but we must be on our guard not to attach too much

importance to these references; first, because they can only be, at last, an imperfect calculation; and secondly, because stages of life succeed each other with more or less rapidity, according to the climate, the manner of living, moral affections, and a multitude of other circumstances. For instance, we know that puberty begins very early in warm climates, that it begins very late in the northern regions. It is related, that *Bébé*, a dwarf of the king of Poland, was in a state of decrepitude while only 23 years old, &c.

CHAPTER II.

OF INDIVIDUAL DIFFERENCES.

Organization is the fundamental character of every living being; but this organization presents, in each subject, a number of individual modifications, which impart to the phenomena of life immense differences, which must fix the attention of the physiologist in as much as they are compatible with a healthy state. These differences or individual distinctions, when considered in man, may be referred to the following: 1st, one or more organs may have their functions with a character of irregularity sometimes very singular, without, however, there resulting from this any general influence over the organization in general; these are named *idiosyncrasies*. 2d, Other and more considerable differences or causes, act on the apparatus of one of the principal functions and impress the whole economy with a peculiar physical and moral physiognomy, whence results what have been termed *temperaments*. 3d, Or, these individual distinctions may result from the repeated action of external agents, and from the continual exercise of the same organs: then they constitute acquired differences, called *habits*. 4th, Finally, there are certain individual organic modifications which seem to be intimately connected with the primitive organization of man;

these give rise to the distinction of the different *races of men.* We shall briefly treat of each of these differences, in as many separate articles.

ARTICLE 1.

Of Idiosyncrasies.

In its etymological sense the word idiosyncrasy is synonymous with temperament; but from the most common application, it designates an individual difference, either acquired or congenital, consisting in a functional irregularity mostly confined to a single organ, the function of which contrasts in the most singular manner, with that which it commonly fulfils.

Almost every practitioner has had it in his power to remark some of these singular anomalies; for there is not a single function in which we have not frequent occasion to remark similar instances; we shall therefore indicate those which are most remarkable in each of these functions.

Digestion. It is related that a friend of the celebrated *Tissot* was in the habit of vomiting after having eaten sugar, although he was in perfect health. In this respect, we know how much taste varies: thus some persons can eat with pleasure the most disgusting things; and often substances of an easy digestion, for the generality of persons, are indigestible to others, &c.

Absorptions. They present no less remarkable peculiarities than the preceding functions; witness the promptitude with which certain persons absorb putrid, deleterious and contagious miasma, while others exposed to the same influences escape unmolested.

Respiration. We are well aware, with respect to this function, that men present great differences; some have it naturally short and quick, whilst it is deep and slow in others. I am well acquainted with a person, otherwise well formed and in good health, who, after three or four inspirations, is involuntarily led to sigh deeply.

Circulation. It likewise presents remarkable irregularities. Indeed, what great differences do we not observe in the quickness, duration and fulness of the pulse; it is related that the pulse of NAPOLEON only beat *forty-four times* in a minute.

Assimilation, *calorification* and *secretions*, are equally liable as the preceding to irregularities. For instance, we see men remain emaciated and of a spare habit in the midst of plenty and the comforts of life, whilst another acquires strength and corpulence at the very time he even lacks the most common necessaries.

Sensations. It is especially in the functions of sensibility that idiosyncrasies are most observable. What whims do we not remark in men with respect to the senses? With some, the touch of velvet produces nausea and syncope; with others, the most savory and dainty dishes become, for their taste, the most unpalatable food; the most delightful odours, for some persons, are the most detestable to others; the Hindoo holds in abhorrence the smell of viands, whilst *Haller* was scarcely conscious of the effluvia arising from putrified cadaverous bodies; *Gaubius* cites the case of a man who could not bear the emanations from females; *assafœtida* and the *chenopodium vulvaria* are fancied by affected coquets to be the most fragrant and sweet odour; a young man is seized with epileptic fits every time he looks at

a red object; a celebrated English chemist can not distinguish the deep orange colour (*rutilante*) of the nitrous acid. The sense of hearing presents just as many remarkable singularities: *J. J. Rousseau* relates, that a young man was afflicted with a retention of urine on hearing a bagpipe; see what amazing different effects are produced by harmonious music, on a clown and on a professed amateur of music, &c.

The cerebral functions do not present fewer anomalies; we know how men differ with respect to the nature and extent of their intelligence. Finally, in the functions of generation there are also anomalies; some enjoy in the act of copulation the most lively delight, while others do not derive from this action the least pleasure; the former may become the mother of a numerous and beautiful offspring while the latter, in spite of the most ardent desires, the most frequent and the best combined attempts, will leave her name, and her fortune without an heir.

These idiosyncrasies are well known in their effects, but we are entirely ignorant of their nature, and of their origin, as well as of a multitude of other natural phenomena; however, we refer them generally to the peculiar texture of the organs, and their kind of sensibility.

ARTICLE 2.

Of Temperaments.

We commonly designate, under the name of temperament, the individual differences, consisting in the variety of development, and activity of the diverse organic apparatus of the human body, capable of modifying the whole organism, in an appreciable

manner, but nevertheless compatible with health and life.

The ancients considered our bodies as formed by the union of four elements; the *heat*, the *cold*, the *dry*, and the *humid*, united in four different combinations, to each of which they ascribed the predominance of one of the four humours: the *blood*, the *bile*, the *atrabile*, the *pituita*, on which they particularly dwelt. According to this opinion they describe four principal temperaments, the *sanguineous*, the bilious or choloric, the *atrabiliary*, or *melancholic*, finally, the *pituitous*, or *phlegmatic;* afterwards from their combination they formed the *mixed* temperament, and the one resulting from their harmonious intermixture, was called *temperate*. They also described with so much eloquence and fancy, the physiognomy belonging to each of these temperaments, that their doctrine prevailed till a very late period with all the appearance of the greatest correctness.

But then, what are these four elements, *hot*, *cold*, *dry*, and *humid*, except the products of a poetical imagination? In the second place, what do they mean by the atrabile, and the pituita? where are these humours? who has seen them?

Some modern physiologists admitted the sanguineous, bilious, and phlegmatic temperaments of the ancients, ascribing them to the predominance of the vascular, lymphatic, and hepatic apparatus; subsequently, they added two others, the nervous and the muscular or athletic.

Hallé, taking into consideration the influence of the general systems diffused throughout the whole economy, their peculiar disposition in the different regions of the body, and the predominance of some

of the most important organs, distinguished the temperaments into general and particular. Thus, from the predominance of either the sanguineous or lymphatic systems, or an equal distribution of each, he forms three general temperaments, which correspond to the sanguineous, bilious, and pituitary of the ancients: afterwards observing the nervous system in its susceptibility, of the duration of its impressions, the readiness with which they associate with and succeed each other, he demonstrates that these conditions arise from the preceding temperaments, on which they impress different modifications. Finally, in considering another general system, the *muscular apparatus*, he establishes the *athletic* temperament, and the *nervous convulsive* temperament, when it coincides with the great excitability. With respect to the particular temperaments of *Hallé*, they are owing, 1st, to the proportions which affect the different general tissues in the several regions of the body; 2d, and to the predominance of certain organs: in this case, *Hallé* points out three principal ones, the *pituitary*, characterized by the abundance of mucous excretions; the *bilious*, properly so called, in which biliary secretion predominates; finally, the *melancholic*, ascribed to a special state of the hypochondriac viscera, and to the nervous epigastric centres.

Lastly, M. *Rostan* has published a history of temperaments, if possible, still more physiological, taking, for its foundation, the predominance or deficiency of the different organic apparatus, which in the human economy fulfil the most important functions.

1. *Temperament, in which the digestive apparatus predominates.* The individual in whom this

apparatus predominates, is remarkable for his voracious appetite, the power of his stomach, and the rapidity of his digestion; a part of the bile, the secretion of which is very abundant, is absorbed, and passes again into the circulation, stimulates the internal organs, and imparts to the whole surface a darker complexion. The man, thus constituted, is no less remarkable for the development of his intellectual faculties than the vivacity of his imagination; he knows no moderation, he performs with violence and obstinacy, what he undertakes with audacity; in a word, his passions are impetuous. This is the temperament which belongs to tyrants, to men of genius, to benefactors, to conquerors, &c.

2. *Temperament, in which the respiratory and circulatory apparatus predominate.* It is characterized by the strong development of the chest, and of the thoracic organs, the power and activity of their function, the fulness and vivacity of the *pulse;* the organic functions are easily performed, movements are quick and easy; imagination is less vast, but animated and agreeable; the mind is unsteady, consequently unfit for meditation; the passions are less violent, impressions succeed each other with rapidity, and only leave fugitive traces.

3. *Temperament, in which the encephalon and its dependencies prevail.* In the persons possessed of this constitution, life seems to have forsaken the vegetative functions, to impart the whole of its power to the nervous apparatus; the body in this case is slender and thin; the skin is dry and cold, with a melancholic physiognomy; digestion slow and laborious; the pulse feeble and slow; movements are marked with circumspection; sensations, on the contrary, are lively, the passions unremitting, the

man thus organized is possessed of a gloomy and unstable imagination, but always active, and of a very great penetration. When this constitution is united to the first just mentioned, then we have men who astonish the universe, such as *Pascal, Rousseau*,* *&c.*

4. *Temperament, in which the locomotive apparatus predominates.* In this temperament, on the contrary, all the organic functions are full of energy, the bones are very well developed, the muscles are strongly marked, the chest wide, the shoulders broad, the muscular fibres, being dense and strong, are capable of enduring the greatest efforts; but, on the other hand, to compensate for these advantages, sensations are quite obtuse, the mind heavy or very common,† the passions moderate, &c.

5. *Temperament, in which the genital apparatus prevails.* It is characterized by a considerable development in the sexual organs, and the activity of its functions, by amorous desires incessantly renewed, a lewd imagination, frequent erections, a strong and thick beard, a considerable corpulence, a low and sonorous voice. This erotic exaltation is more frequently met with in women than in men. It co-exists generally with great activity in the digestive organs; without this condition, the inor-

* We know no man, who better illustrates this latter temperament than NAPOLEON. TRANS.

† Neverthless, there are exceptions; *Plato,* for instance, after having vanquished in the arena, became the greatest genius of his time. (1)

(1) And we may also add the name of the immortal Washington as an exception to this rule. TRANS.

dinate use of this function inevitably leads to a premature death.

6. *Temperament characterized by the atony of all the organs.* The body is heavy, pale, and incumbered with too great a corpulence; the physiognomy is without expression, motions are slow and difficult, digestion is long and laborious, circulation without energy, the pulse soft, easy to compress. The moral faculties present not much more activity, sensations are indistinct, the mind is correct, but deficient in vivacity and penetration. The man endowed with this temperament, is indolent, incapable of enduring pains, exempt from passions, and very little fit for venereal pleasures.

7. Finally, from the proper development of various organic apparatus, coinciding with a proportionate energy in the nervous system, *Rostan* deduces what he calls a strong constitution. Let it be understood, that he does not mean the muscular power which characterizes the athletic temperament, but that indescribable power by which health is rendered stable, and opposing itself to the morbific causes which always tend to alter and destroy our constitution. From contrary combinations, or inverse circumstances, we necessarily shall have an opposite constitution. It is by carefully and successively observing the different functions, that we are enabled to judge of the energy, and of the proportion of their apparatus, and consequently of the degree of force or debility of the constitution; for every individual has one which is peculiar to himself, and this is another great source of peculiar and individual distinctions.

All the individual differences that we have just studied, may be natural or acquired. There is not

the least doubt that parents transmit to their children their physical or moral resemblance, and consequently, some of their morbid and intellectual dispositions, &c. It is undeniable that children are born endowed with a peculiar organization, from which often results their future temperament, and the degree of strength of their constitution; but it is equally correct to say that this primitive organization may be modified by the influence of exterior circumstances, so as to receive a particular character and utterly different dispositions: in fact, what amazing differences do we not observe between the men who inhabit the temperate or ardent tropical climates, and those who live among the glacial regions of the poles; between the man who is surrounded with all the comforts of this life, and he who feeds on privations and wretchedness; between the temperate and sober man, and he who spends his life in riot and debauchery; between the man who leads an active life, and he who shamefully leading a life of idleness, abandons his organs to a continual and disgraceful repose; between the man whose intellectual and moral faculties have been cultivated, and the unfortunate person who has not enjoyed the blessings of a good education; lastly, between those who taste the sweets and happiness of liberty, and those who are condemned to servitude and oppression.

ARTICLE 3.

Of Habits.

The name of habit has been given to functional modifications, which constitute a new organic law as

influential as natural power, and resulting from the repetition of actions or sensations long continued.

The economy of man yields to the influence of habit more than any other animal, and this peculiar condition was indispensable to the part he has to perform in the universe; in fact, man, created capable of inhabiting every quarter of the globe, must require and enjoy great flexibility of organization to accustom himself to the various climates and to the diverse aliments they necessarily produce; doomed to live by the product of his industry, and benefit by the same society at large; it is especially to the great flexibility of his organs that he is indebted for his astonishing degree of superiority in the arts and sciences.

Every stage of life is not equally influenced by habits; for instance, in the same degree as it is easy for children or females to contract a new habit, in the same proportion the hardened organs of the old man refuse to yield to the introduction of a new habit in his manner of acting.

Habits exercise their sway over all the functions; we shall briefly examine them each individually. And, first of all, who is not acquainted with its influence on digestion; it regulates the epochs at which appetite is felt; it is the same cause which so imperiously calls for certain aliments and particular drinks; it also often rules the taste and quantity; finally, it is by habit that the most indigestible aliments or even deleterious substances, no longer produce their usual effects. The history of *Mithridates* is well known, who could not put an end to himself by the use of the most active poisons, because he had previously been accustomed to their action; we are also acquainted, that numerous tribes

in the east eat great quantities of opium with impunity; and experience daily proves to the physician, that remedies cease to act whenever the dose is not gradually augmented, or by a too long continued use of the same article.

Respiration is no less influenced by habit; that night-men are enabled to breathe in an atmosphere in which we should suffocate. I read the remarkable history of a prisoner, who after having been confined for thirty years in an unhealthy dungeon, had a fit of illness when he was taken out of it, and could not be restored to health but by returning to his infected cell.

It is especially over sensations that the influence of habit is very considerable. We are aware how much the impressions of cold and heat may be modified; we know also how much the delicacy of the sense of touch and other senses may be developed by habit: a very singular instance is related of a blind man who could tell the colour of a stuff about which persons with good eyes disagreed by candle light. Taste and smell is no less susceptible of being perfected by habit; what immense difference does not exist among men with respect to the nicety of the palate and nose? The same is the case with regard to the ear. Consider the Indian who can distinguish the step of an enemy at a prodigious distance; behold the musician whose ear is shocked at a false note in a full orchestra; sight is also capable of acquiring a great degree of perfection. But if habit extends the sphere of the senses, it most frequently confines it, by blunting them: thus the sense of touch loses much of its nicety by rough work; that a savoury dish no longer produces any impressions on a palate impaired by the habit of

using strong spices; that a man who makes use of tobacco is obliged to augment gradually the strength and the dose; that the sense of hearing becomes hard by continual noise, and that the sight loses much of its delicacy when it is accustomed to too great a light, &c. &c.

Voluntary movements are influenced by habit in a very remarkable manner; by habit they acquire that astonishing degree of precision and agility; and it is by habit that the muscles become susceptible of producing the greatest efforts. The duration of sleep also, is not unfrequently the result of habit.

Finally, we also remark the influence on the functions of generation: Professor *Richerand* relates the very remarkable case of a shepherd, who almost during forty years successively made use of his hand, of a stick, and of a sharp instrument, in order to procure the voluptuous sensation which commonly attends the ejaculation in coition, and which in this individual was gradually extinguished by the habit of masturbation which he repeated several times in the course of the day. At other times, onanism produces a contrary effect; it plunges the sexual organs in such a degree of excitation that the slightest friction produces the seminal ejection. Finally, it is well known that the habit of indulging in the erotic pleasures enables us to support their excess.

From the preceding remarks, we gather that *Bichat* was mistaken when he supposed that habit extended its influence only over the animal functions; it is now placed beyond a doubt that the vegetative functions are equally subjected to its law; and this result was easy to anticipate by reflecting that vegetables themselves are influenced by the habit of being in a peculiar soil, localities, &c.

We have already observed that habits are the result of the continuation of the same actions or impressions; and this we may have remarked in the analysis we have just given, since we have seen that sometimes the actions, at other times the sensations, were modified by their repetition.

The general effect of habit is to remove the functions from the natural organic law, and to assume over the actions and will of man a tyrannical sway, from which he can not free himself without exposing his health to the most serious accidents; this is the reason why habit has received the well-deserved appellation of *second nature.* With respect to their immediate effect, it has generally been repeated, after *Bichat*, that they *blunt sentiment* and *improve judgment.* Nevertheless, if it be true, as we have already shown, that they gradually lead sensations to indifference, it has also been demonstrated that habits can exalt them to a very high degree; witness the savage who can hear at an astonishing distance, and the musician who leads an orchestra. Professor *Richerand* to this observes, that the ears are not the organs that hear, and that the impressions they receive must be considered as the cause of the sensation, the perceptions of which is entirely confined to the cerebrum; but does this objection bear on the case of the prisoner, who had acquired such great susceptibility of receiving impressions on the eyes, that he was enabled to distinguish perfectly, objects in his dark dungeon, and to whom day-light had become intolerable? Messrs. *Rostan*, *Adelon*, and other physiologists admit, 1st, that gradually augmenting excitations at last blunt sonsations; 2d, that gentle impressions increase the sensibility of the organs, and exalt it to such a degree, that strong impressions

become painful; 3d, finally, that the organs lose or acquire aptitude or energy, according as the repetition of their actions is more or less continued, and requires from them more or less activity.

It is impossible for man to withstand the power of habit, for there are many which irresistibly subjugate him; but in these he generally finds laws which regulate and facilitate his life; whilst there are a multitude of others that are solicited by social circumstances, and which, most frequently, are very pernicious; he must avoid them as much as lies in his power, or he will continually create for himself new tyrannical wants, in which he must indulge, or suffer in the denial.

ARTICLE 4.

Human Races.

The distinctions between human races are founded on the generic differences of the primitive organization of man; their study exclusively belongs to natural history; therefore we shall confine ourselves simply to relate, in this place, the opinions of the most eminent naturalists on this interesting subject.

Buffon acknowledged but one human species; he says that all the *races* are linked to each other from one climate to another, and that the peculiar characters remarked are the result of exterior influences; however, it is generally admitted, that the species are not so distinct as in the brutes; but are what has been called *races*. M. *Cuvier* has divided them into three: the *Caucasian* or white, the *Ethiopian* or black, and the *Mongolian* or yellow.

1. *Caucasian Race.* This race is the most handsome, and the most perfect; it is remarkable for its oval head, and for its very great facial angle. It

inhabits Europe, Syria, Persia, Asia Minor, the Peninsula this side of the Ganges, Arabia, the northern parts of Africa, and on the north of Mount Atlas, &c.

2. *Ethiopian Race.* This race has some features in its organization which assimilate it to the monkey. The forehead is depressed, the cranium has less capacity than in the preceding race; the whole face is proportionately too much developed; the maxillary bones project out, especially the inferior, which is very long; the inter-maxillary bones are met with in the embryo, which never happens in our race; the lips are very thick; the molar bones are prominent; the zygomatic apophysis very much arched; the nose is flat; the hair is crisped, woolly, and very fine; the skin, the blood, the cortical substance of the brain, and some other interior parts are black. This race is not so numerous as the first; it inhabits Africa from the southern parts of Mount Atlas, to the cape of Good-Hope.

3. Finally, the Mongolian or Tartar race, has an olive-coloured complexion, with thin hair and beard, short and black, the head is large, the molar bones very prominent, the eyes are oblique from above downwards, and from without inwards. They inhabit the extent of the globe comprehended between the eastern parts of Asia and the Caspian sea, and the southern ocean, China, Chinese Tartary, and Japan; this is the most ancient race.

To the three above mentioned races, *Lacépède* adds two others, the *American race*, with copper coloured complexion, and inhabiting North America; and the *hyperborean* races, such as the *Laplanders, Greenlanders, Samoiedes*, &c. The *Albinos, Cretins*, and *Cagots*, are generally considered as individuals affected with peculiar diseases.

CHAPTER III.

OF SYMPATHIES AND SYNERGIES.

In the particular history of the functions of man, we have pointed out the principal relations that he established with exterior bodies, in order to insure his own existence. We shall in this place briefly examine the numerous and diversified connections which unite the various parts of his organization; we are already acquainted with their functional relations; we know, for instance, that biliary secretion is closely connected with digestion; that the same is the case with respiration respecting circulation, calorification and secretions; that the action of the senses is united with the operations of the mind, &c. It now remains for us to study sympathies and synergies.

We designate by the name of sympathies, the involuntary modifications which occur in one or several distant organs, induced by an impression received from another, without our being able to refer this modification to the functional relations of the parts.

Barthez was the first to distinguish sympathies from synergies, and he comprehended under this last expression, the concurrence of simultaneous or successive actions of the various organs, for the accomplishment of a function; for instance, he con-

siders the contraction of the diaphragm and abdominal muscles in defecation as being synergy. M. *Richerand* has kept up this distinction; M. *Adelon*, on the contrary, thinks that it is an object of no importance; he pretends that in both cases, the relation is of an identical nature, and is owing to the same cause. I am far from being of the same opinion with this latter physiologist; he is certainly right when he wishes to destroy this distinction, in the action of the pharynx in deglutition; for as soon as the alimentary bolus has passed the isthmus of the throat, the pharynx contracts sympathetically, *i. e.* independently of every kind of will. But what resemblance does there exist between the action of the abdominal muscles, which is entirely voluntary, and the irresistible influence of the uvula over the stomach, of the retina over the iris, &c.? What do they mean by a sympathy which can be produced or stopped at will?

The number of sympathies is very considerable, and their object is no less diversified; we shall briefly examine them.

1. They may be developed in the different parts of the same organ, tending to accomplish the same function; thus, for instance, the iris is either contracted or dilated, according as the light which reaches the retina is more or less powerful; there exist undoubtedly between the different parts of the ear analogous sympathies, that are concealed from us by the depth of their situation. In some cases, sympathies are developed in very distant organs of the same apparatus; such are the relations existing between the uterus and mammæ.

2. We often observe sympathies between different parts of continuous membranes; these are the

sympathies of continuity of *Hunter*. Thus, for instance, the uvula in tasting, in a manner, the alimentary paste or bolus, predisposes the stomach to receive with more or less pleasure or to reject it. All the parts of the membrane lining the digestive tube seem to possess similar reciprocal relations.

It is by sympathies of this kind that the presence of worms in the intestinal canal induces an itching in the nose, that a vesical calculus is accompanied with a peculiar sensation in the fossa navicularis and glans, which becomes unpleasant or painful; that *an irritation* applied to the *orifice of an excretory canal is communicated to all its ramifications*, &c.

3. At other times sympathies are developed between parts immediately contiguous; for instance, the blood, which arrives in the cavities of the heart, produces on the membrane which lines them, an impression which immediately excites the action of the fleshy layer of the heart; it is by the same mechanism that the disagreeable impression of the stomach, is communicated to the muscular coat and to the abdominal muscles, and solicits vomiting; that the presence of the aliments in the digestive tube, produces the peristaltic contractions of this canal in a more energetic manner than a direct irritation even could produce, as was demonstrated by experiments both by *Bichat* and *Nysten;* that the irritation of the nasal fossæ induces sneezing, that the introduction of a foreign body in the bronchiæ, induces cough, &c. Such are the sympathetic relations, that *Hunter* calls *sympathies* of *contiguity*.

4. Sympathies seem to unite closely the organs, the structure and functions of which are analogous;

these sympathies become evident, especially in a morbid condition; thus, for instance, we see in a very short time the inflammation of a tonsil disappears and is transferred to the other; we are well acquainted with what rapidity an articular rheumatism is transferred from one joint to another; it is not unfrequent to see this affection, at first fixed on one muscle, to go through the whole locomotive apparatus in a very short time.

The following case is the most remarkable with which I am acquainted on this kind of sympathies: *Barthez* relates, on the authority of *Zhedon*, that a blister applied on a paralysed arm produced its customary effect only on the corresponding part of the opposite limb. Some physiologists refer to the same sympathies, the harmony existing in the movements of the eyes.

5. Finally, there are sympathies which radiate from a single organ through the whole economy, or reciprocally. Let us suppose, for instance, the blood impoverished by a too prolonged abstinence from food, soon the organ, finding no longer sufficient nutrition to repair the losses of the economy, suffer and languish; it is the stomach they solicit, it is this organ which warns us of their wants; no sooner is hunger satisfied than the organism proclaims a fresh energy, even before digestion has fairly begun.

The genital apparatus is another centre or focus no less prolific of general sympathetic radiations; all its actions are felt or re-echoed (if I may be permitted the expression,) throughout the whole economy. This apparatus in females seems to hold under its dependence their organism, as was remarked by the ancients, *uterus est animal vivens in muliere.*

The cerebral functions are also in the same case. Behold a man whose mind is seriously engaged; all his functions languish, all his wants are torpid; let the same person pass to light, pleasing, and agreeable amusements, his functions will immediately reassume all their accustomed energy and activity, and his wants will be lively and urgent. Passions produce likewise general sympathetic effects; if they are of a mild and tender kind, the body experiences an indescribable happiness of feelings, (*bien être,*) the soul is satisfied, and the mind is brilliant; the contrary occurs when the passions are violent. Every one knows the adage, *he melts with love, (il se sèche d'amour.)*

The sympathetic phenomena vary in different individuals, according as this or that apparatus of organs predominates in the economy; for instance, if the brain, or the digestive, or genital apparatus predominates, sympathies will have in each case individual peculiarities; finally, sympathies are also liable to vary in force and extent, by more or less activity in the organs, or by their morbid condition; in the latter case sympathies become more obvious, and all the organs may become the seat or centre *(foyers)* of general radiations *(fevers;)* but in every case the intensity of the general sympathetic disturbance varies, according to the intensity and nature of the affection, and according to the normal organization and activity of the affected apparatus.

We are now able to observe, that in all sympathies we have had two things to consider, their seat *(foyer,)* or point of departure, and the extent of their radiations. This is what *Bichat* called *active* and *passive* sympathies; these are incorrect expres-

sions, and calculated to create false or erroneous ideas.

Now, what is the agent by virtue of which sympathies are developed? In a word, what is their organ? Physiologists are far from agreeing on its assignation. *Whytt* ascribes them to the soul; M. *Roux* thinks, that sympathies are independent of organization; and he considers them as the result of vital properties, to which he gives, consequently, a real existence. *Bordeu* attributes them to oscillatory movements of the cellular tissue; other physiologists have tried to explain them by means of the vascular system; but the hypotheses advanced with respect to this subject are untenable.* Finally, some

* The candid and philosophical confession of Professor N. Chapman, on our entire ignorance of the nature of sympathy, is far preferable, with a lover of truth, to the finest spun hypotheses on the *agent* or *nature* of this mysterious, but no les existing cause. We think it proper, in this place, to quote from Professor Chapman's Therapeutics, the following passage, which ought to be well impressed on the mind of every student, whenever he hears or utters the word *sympathy*.

"It must be confessed, we have no very distinct intelligence relative to its nature. But are we on this account to question its existence? Equally might we doubt the sensibility or irritability of the body, since neither of these qualities of vital matter has been at all demonstrated. Notwithstanding this, we are persuaded of their existence, from the phenomena which they exhibit—and it is by the same description of evidence, that we are, or ought to be, assured of the existence of sympathy.

'*Causa latet: vis est notissima.*'

"In employing this term, therefore, I mean only to denote, like *chemical affinity*, *caloric*, and many other such expressions, a principle or power, of which we know nothing except from the experience of its effects, the precise essence or nature being occult and concealed." TRANS.

ancient writers, and most of the modern authors, ascribe all the sympathies to the nervous system. In fact, it is the system most widely diffused in the economy, and all its parts terminate in a common centre; in a word, its actions are as rapid as thought itself: Such are undoubtedly the most favourable conditions for a clear and satisfactory explanation of the sympathetic phenomena.

The nervous system may establish sympathetic connections in two ways: 1st, the organs, between which sympathies occur, communicate with each other through the ramifications of the same nerve or through anastomoses; 2d, or the sympathetic radiation terminates in the nervous centre, whence it is reflected on one or several organs.

From these two sympathetic conditions result, 1st, *direct sympathies*, that *Vieussens*, *Meckel*, and *Boerhaave* believed to be the only ones. 2d, *Cerebral sympathies*, that *Willis*, *Haller*, *Broussais*, *Georget* and *Adelon*, consider to be the most numerous.

An acquaintance with the effects of sympathies is of the utmost importance, and we daily meet in the practice of medicine, with cases in which their existence is made manifest; it is by them that we are often induced to apply or use a remedy in this or that part according as it sympathizes more or less with the affected organ, &c.

Synergies differ from *sympathies* only because they are entirely dependent upon volition; and they consist in simultaneous or successive actions, voluntarily directed to the accomplishment of the same object. We have already remarked the pharynx contracting irresistibly at the time of deglutition, and the iris also to shut up closer, independently of

volition, under the influence of a lively light. We shall see that the same is not the case with the action of the abdominal muscles in defecation, in labour, and in the excretion of urine. When, for instance, the call for the passage of the fæces becomes irresistible, after having been for a long time suppressed, we do not remark the abdominal muscles contract in a sympathetic or involuntary manner; but what we may easily remark, is, that the fecal matter is ejected from the anus by the simple action of the rectum, and if obedient to a pleasure which induces us to join to it a secondary power, then we ordinarily associate the action of the abdominal muscles: but their contraction is, nevertheless, in every case, dependent upon volition: the same thing is the case in labour (*accouchement*); we are, in fact, well aware that females can prevent the action of abdominal muscles, at the time of the contractions of the uterus; is it not from this fact that we encourage the female patient to *take advantage of her pains, not to eat*, or *not to check her pains?* Finally, it is also by volition that the abdominal muscles are associated to the action of the bladder, to produce the excretion of urine.

CHAPTER IV.

OF DEATH, CADAVEROUS PHENOMENA, AND PUTREFACTION.

NATURE having endowed us with the faculty of reproducing ourselves, was unavoidably obliged to impose on us the inexorable necessity of dying; otherwise the globe would soon be incumbered, and would be insufficient to contain our continually increasing species, without the foreseen and indispensable ravages committed by death. We designate under this name the utter and definitive cessation of the phenomena of the organization, the harmonic union of which characterizes life; it is the termination of our career. It is distinguished into two species, *natural death*, and *accidental death*.

1. *Of natural death.* In the study of *ages* we have just made, we have observed the organization gradually reach, by a series of stages, the brilliant period of life, and to remain for some time in a seemingly stationary state; we have afterwards followed it in all the stages of its decline, and in this last period we have pointed out the progress of the deterioration of the organs; we have seen the functions languish, even completely disappear, and the rapid course of decrepitude to announce an approaching death. Digestion every day slower, and more imperfect, affords but little chyle, and that

not well elaborated; respiration slackened, only produces an imperfect hæmatosis, the blood being cold and impoverished by all the above mentioned reasons, is sent but partially into all the organs, the life of which becomes progressively languishing and uncertain. For a long time the power of reproduction has ceased to make any call on the subject; and the blunted senses are every day more and more obliterated; all the faculties of the mind and of the heart are gradually spent; the voice is weakened and soon extinguished; in a word, the circle of the vital phenomena becomes every day narrower. Man in this state soon loses the recollection of his own existence, and from this moment he no longer lives for himself; like to an oak which dries up, by slowly exhausting the little sap which yet remains, and the least commotion, the least disturbance, would suffice to stop for ever the spring of life; but he still exists; and innervation, respiration, and circulation, prolong for a short time a lifeless existence, and seem to reach the last degree of exhaustion by reciprocally supporting each other; finally, one of these languishing functions ceases, and immediately the whole edifice falls into ruin. From these three roots of life, it is probable that innervation is the first to be overcome; that from this moment the action of the lungs is arrested, and that, finally, the blood, being no longer admitted into these organs, gathers in the right cavity of the heart which dies the last.

2. *Of accidental death.* We understand, by this event, when man is struck with death before his organs are deteriorated by the ordinary course of life, and he is not subdued by exhaustion. This kind of death is without doubt the most common in our

times; and it seems that its frequency augments as the world becomes older and civilization advances. Its causes, although very numerous, may be referred to the following: 1st, the privation of air and aliments; 2d, the mechanical disorganization of the first apparatus of life; 3d, the substances which, introduced into our economy, destroy the organs, or annihilate the nervous action, the spring of life; such are *poisons;* 4th, finally, all the morbid movements which are so frequently developed in our organs, spontaneously, or influenced by a natural agent.

It is easy to conceive that from this great diversity of the causes of accidental death, the accompanying phenomena must be various and infinite. Sometimes one of these causes inflicts a violent lesion on one of the central organs, then death is sudden or happens soon after; at other times, it acts with a sort of caution, the progress of the affection that it solicits is slow, the deterioration of the organs comes on gradually, and induces in six months, or one or two years, a premature old age; death, in this case, is slower the less important the affected organ is to life.

Death, we have already remarked above, is the entire discontinuation of the vital acts; but now, what is the cause of this cessation of life, or, in a word, what is the cause of death? When man is subdued by the disorganization of one of the central organs, or the disorganization is the consequence of a complete disturbance, conveyed sympathetically in all the functions, through the sufferings of an organ, then, in this case, death has nothing which ought to astonish us, or that physiologists can not explain. If, for instance, innervation is suspended or exhausted by a direct or sympathetic alteration

of the nervous centres, or by a cerebral hæmorrhage, or by pain. I hope it will be easy to conceive how the loss of the first spring of the economy should necessarily cause that of all the others; the same thing occurs here as in a watch, the main spring of which happens to be broken. The same thing will take place, but in a different manner, if the lungs or heart happens to be hindered in their functions. In the former case, sanguification, being very imperfect or even interrupted, will prepare for the organs only a cold and impoverished aliment, which will soon be insufficient to excite to action the nervous centres; in the second case, if the heart is affected, the languor or the stoppage of its action, will produce the same effects over the focus of innervation and of life, &c. In a word, accidental deaths commonly have nothing in themselves, for which we can not account.

Natural death, at the first glance, seems more extraordinary and more difficult to explain; we shall see that it occurs by the progressive decrease of the four fundamental functions of life. In the last periods of decrepitude, the appetite, which for a long time had lost from day to day all its activity, ends in completely disappearing, or almost completely; the few aliments which reach the digestive tube are but slowly and imperfectly digested, a very small quantity of chyle, very little animalized, is with difficulty conveyed together with the venous blood into the lungs; these organs, the ossified aerian tubes of which are often narrowed, have lost a great part of their vascularity by the obliteration of their capillary vessels, (as we observe it in the placenta as the fœtus approaches the period at which the child is going to change its mode of life), and in conse-

quence of these changes, hæmatosis is no longer executed but with difficulty, and in a very imperfect manner; on the other hand, the heart flabby, and without energy, sends only with hesitation the blood into all the organs; the ossification of the arteries, the obliteration of the capillary vessels, aid the sluggishness of the circulation; the veins, being dilated, lose their elasticity, and the return of the blood becomes more and more slow and difficult; in the mean time the brain withers, the nerves become tough and hard; consequently, the activity of innervation progressively diminishes, and the already languishing life of organism, loses the remainder of its energy. These four principal functions deteriorate at every instant, and hasten their destruction by their reciprocal influence; finally, life is extinguished as we have already mentioned before.

Such are evidently the causes of natural death; they are, as we have seen, less obscure than is generally promulgated. But what is entirely in darkness, and what must remain probably for a long time unknown, is the cause of the succession of ages, and of the infinite modifications that organization experiences in the course of life, and in consequence of the series of the deteriorations which leads to death; in order to unveil this mystery, it would be necessary to discover the principle and the essence of life.

Cadaverous phenomena. As soon as the body has ceased to live, it takes the name of *cadaver* or *corpse;* from this moment it presents the following characters; 1st, it loses by degrees its heat, and becomes as cold as ice; this effect is the sooner felt, as the stillness has been longer, and emaciation greater; 2d, it is in a state of complete insensibility; 3d, it is

motionless, and only obeys the impulse of foreign bodies or its own weight; 4th, it presents a remarkable state of flaccidity or stiffness; during the first moments which immediately follow death, all the parts become flabby and pale; but in proportion as animal heat is dissipated, the tissues resume some consistence, the muscles experience a kind of contraction or rigidity which produces the *cadaverous stiffness*, generally supposed to be a remainder of contractile power.

It is not uncommon to observe some phenomena of vegetative life to continue even after death; thus M. *Magendie* has remarked that absorption could be carried on; other physiologists assert having seen the beard and hair grow; some think that digestion can yet make a last effort; we know at least that this function, as well as several others, have been prolonged in cadavers by means of galvanism. Some authors have asked if secretions do not continue for a certain time after death: we know with certainty that some secretions occur; thus the rectum, the bladder, and the uterus, are known to have frequently accomplished after death, their actions of ordinary excretions.

With respect to the fluids, they remain stagnant in their vessels. The blood accumulates in the venæ cavæ, in the right cavities of the heart and the vessels of the lungs; the arteries empty themselves by their own elasticity, and in the same degree as the animal heat is dissipated, the capillary vessels contract, and the tissues become pale in proportion as the blood retreats into the larger veins; from this moment, obedient to the laws of gravitation, it is conveyed into the most declining parts, and the different tissues are thus impregnated with it. Hence

those livid spots that we remark in the various regions of the body, and those red or violet stripes which point out the course of the veins. The bile likewise transudes through the walls of its reservoir and of its ducts, and colours with a yellow tinge the neighbouring parts. When the cadaver is entirely cold, the blood first coagulates in the cavities of the heart, afterwards in the veins, and it experiences in its vessels the same alterations as if cooled in the air. Finally, a particular labour of decomposition is now going to take place in the cadaver, and to restore to the chemical and physical laws the elements of a body just now living and animated.

Putrefaction. It is a spontaneous movement of decomposition, occurring in the body when it is entirely deprived of life; it is, according to *Thouret*, the only decisive character of death. The period at which this happens can not be determined in a positive manner, since a multitude of peculiar circumstances may retard or hasten it considerably; as the kind of life led by the individual, the kind of disease to which the individual has fallen a victim, the place in which the body has been deposited, the degrees of temperature and humidity of the atmosphere, &c. Nevertheless, it may be asserted in a general manner, that it takes place from the fourth to the eighth day, when the body is exposed to the open air, for it occurs more slowly in cadavers which have been interred.

As soon as it begins to be manifest, the soft parts gradually soften, the cadaverous stiffness disappears, the humours become fluid and transude through all the parts, which they impregnate with their unpleasant odour. Decomposition commonly begins in the

abdomen, and hence it is extended throughout the whole body; the epidermis first drops off; the flesh soon becomes soft, green, and drops off; the bones remaining naked; and it is not until a long time after, that, deprived of all their organic parts, they are reduced to dust. During this decomposition there is formed, by the reciprocal action of the fermentating elements, a great number of new bodies, the principal of which are: the hydro-sulphuric acid gas, carburated hydrogen, phosphuretted hydrogen, ammoniacal gas, carbonic acid, and some earthy, or soapy solid products.

Thus every thing which recalls to mind the material existence of man is dissipated, and gives birth to new bodies, the successive metamorphoses of which form an endless circle, which put us in mind of the metempsychosis of Pythagoras.

THE END.

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